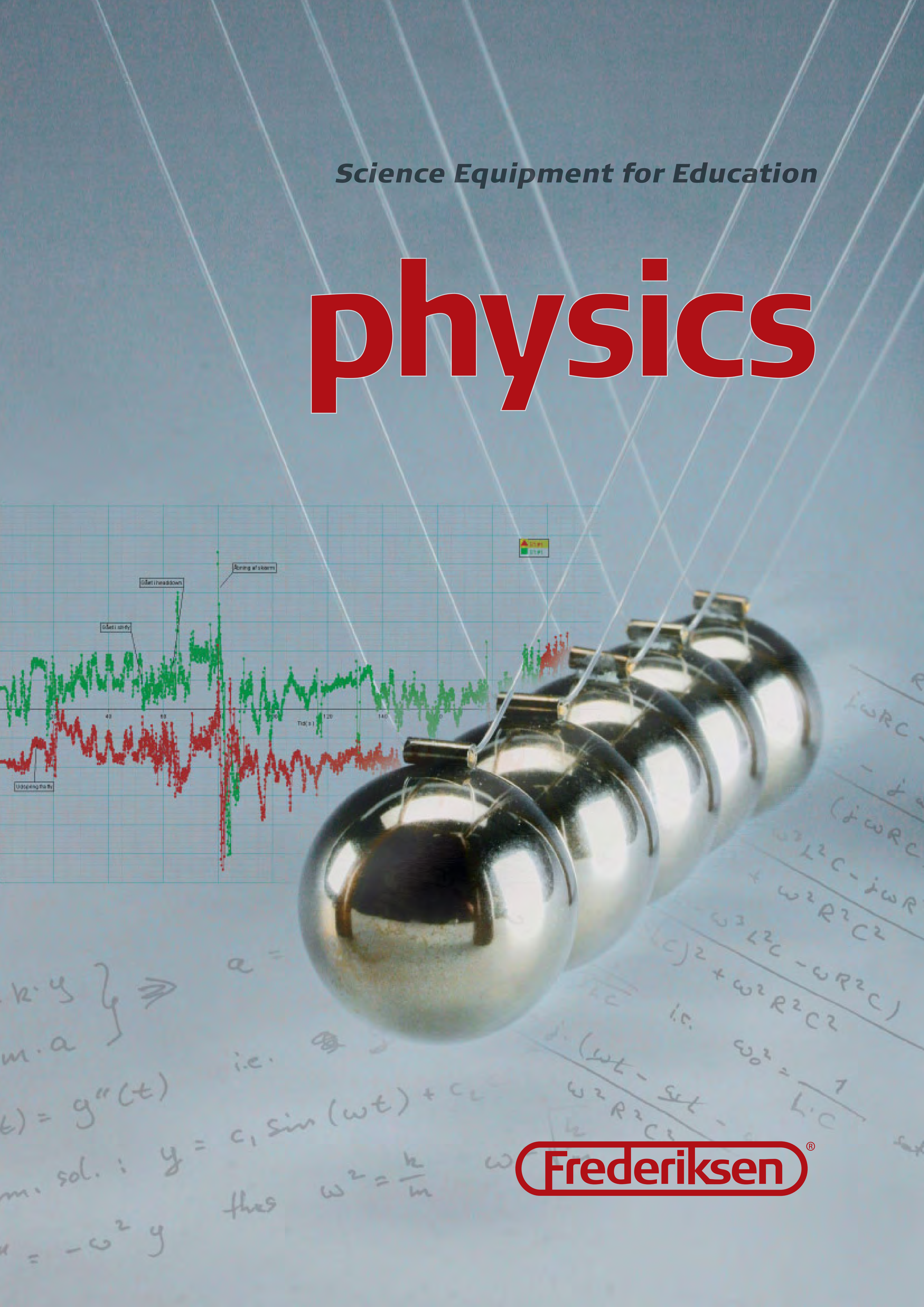
Science Equipment for Education

physics



Frederiksen®

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Physics
Chemistry
Biology
Science/Technology
Lab Equipment

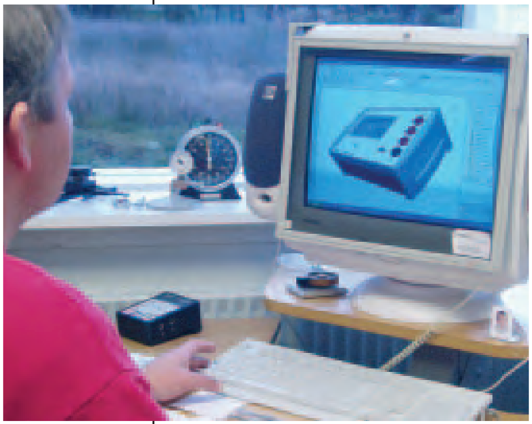
Physics Equipment for Today and Tomorrow

Frederiksen has been developing and producing physics equipment for more than half a century. Physics teachers in Denmark and around the world cooperate closely with Frederiksen in the continuing evolution of new, improved and more versatile equipment to meet changing needs.

Just as Newtons's laws of motion are universally valid, we aim to provide world-wide users with science equipment which is

- *suitable for any curriculum in any country*
- *well-designed and of high quality*
- *competitively priced*

In order to supply you with nothing but the best, we depend on your feedback with comments and suggestions. Whether you want to order new equipment or suggest improvements, please get in touch with us. If you seek advise on applications, feel free to contact your Frederiksen dealer for straightforward information backed by experience.



Development and production

High quality, user-friendly design and pedagogical value for students are keywords guiding our product development group. At the same time we do our best to optimise design for producing equipment for you at the most competitive prices.
Our highly qualified, well trained staff keep up to date on the newest production techniques so that our production department can make maximum use of modern technology.

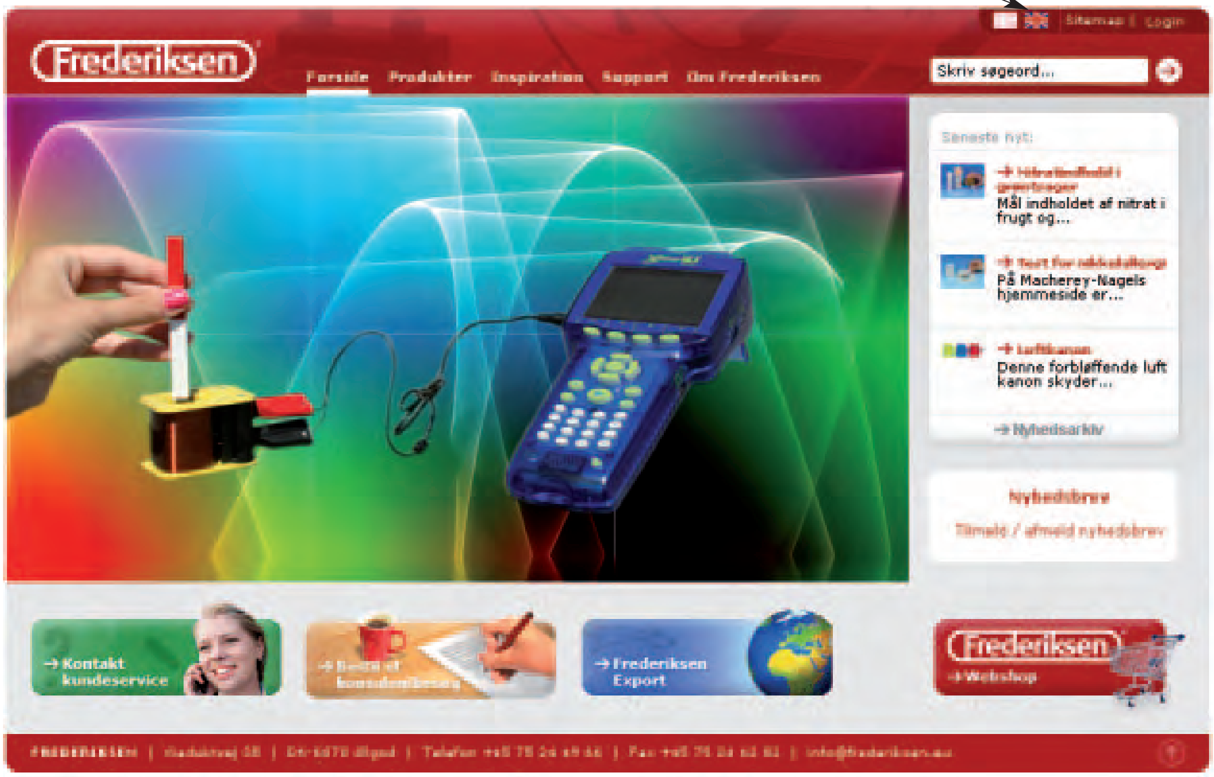
New Frederiksen WEB page

www.frederiksen.eu

We have recently launched our new WEB page www.frederiksen.eu.

It is active in full extent in Danish language and we are working on a new English version also.

In the near future you will find interesting news about Frederiksen and our products here !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Tilmeld / afmeld nyhedsbrev
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Mål indholdet af nitrat i frugt og...

På Macherey-Nagels hjemmeside er...

Denne forbløffende luft kanon skyder...

Laboratory equipment

Retort stand base

A-shape cast iron with stoved enamel finish. Length of feet 200 mm, with 10 mm dia. hole and fixing screw for retort stand rods dia. 10 mm, supplied with rubber feet. Weight: 2.0 kg.

0001.00 Retort stand base

Retort stand base

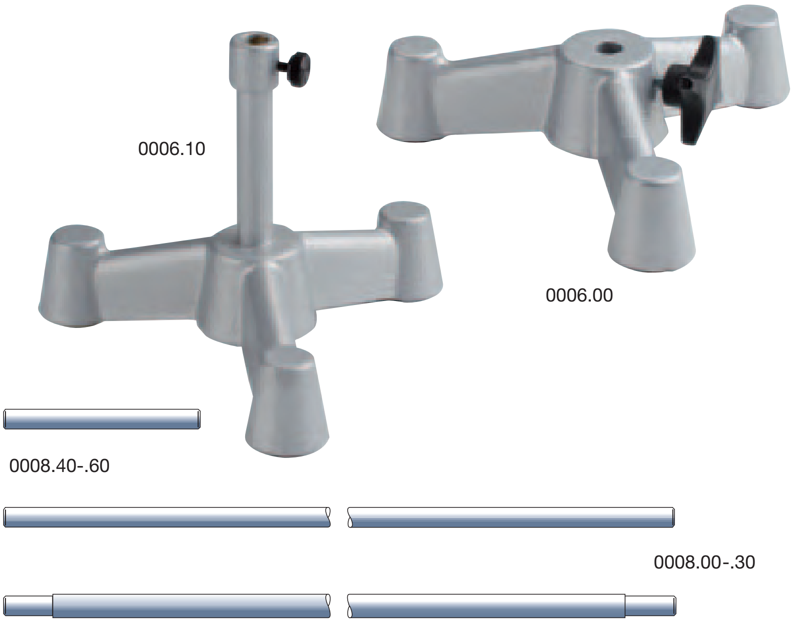
Stump-shaped cast iron with stoved enamel finish, designed to accept 10 mm. dia. retort stand rods, complete with thumb screw.
Weight: 0.43 kg.

0004.00 Retort stand base

Retort stand base

Stump-shaped cast iron with stoved enamel finish, designed to accept 10 mm. dia. retort stand rods, complete with thumb screw.
Weight: 0.57 kg.

0004.10 Retort stand base



Retort stand base

Tripod in cast iron with stoved enamel finish. Designed to accept 10 mm. dia. retort stand rods, complete with fixing screw and rubber feet. Weight: 1.0 kg.

0006.00 Retort stand base

Retort stand base

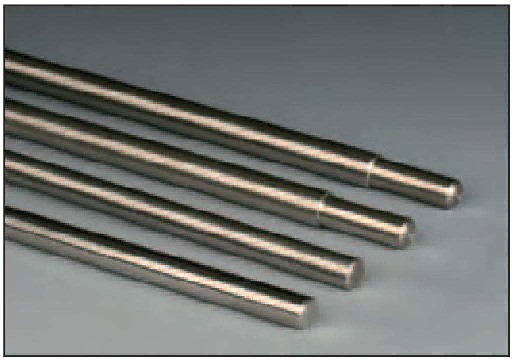
Tripod in cast iron with stoved enamel finish, with vertical tubing equipped with thumb screw. Designed to accept 10 mm dia. retort stand rods.
Weight: 1.20 kg.

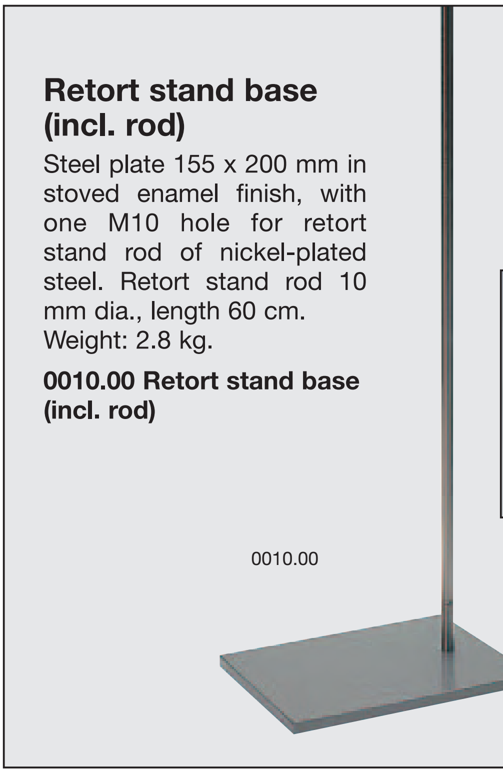
0006.10 Retort stand base

Retort stand rods

Made of polished solid stainless steel 10 mm dia.

No.	Length	Diameter
0008.00	150 cm	12/10 mm
0008.10	100 cm	12/10 mm
0008.20	75 cm	12/10 mm
0008.30	50 cm	12/10 mm
0008.40	60 cm	10 mm
0008.50	25 cm	10 mm
0008.60	10 cm	10 mm





Retort stand base (incl. rod)

Steel plate 155 x 200 mm in stoved enamel finish, with one M10 hole for retort stand rod of nickel-plated steel. Retort stand rod 10 mm dia., length 60 cm. Weight: 2.8 kg.

0010.00 Retort stand base (incl. rod)

Table clamp

Designed for mounting of retort stand rods to the edge of a table. The holes can accommodate rods of up to 13 mm in diameter. The maximum clamp opening is 65 mm. The mass of the clamp is 0.36 kg. The clamp is made of cast iron with stoved enamel finish.

0016.00 Table clamp

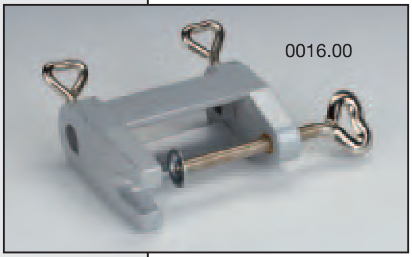
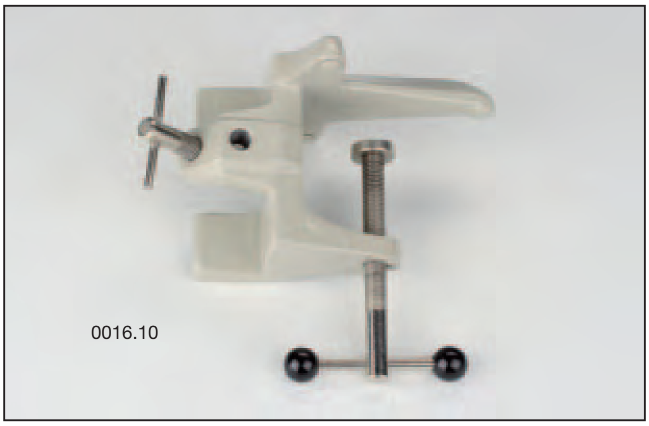
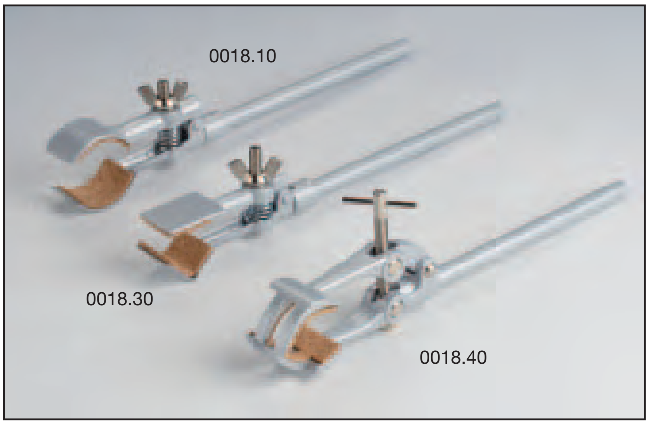


Table clamp, universal

Designed for securing round or square retort stand rods up to 25 mm in diameter or plates up to 20 mm thick. The clamp can be mounted on the edge of a table, thickness up to 56 mm. Manufactured of cast iron with lacquered finish. Weight: 1.2 kg.

0016.10 Table clamp, universal





Clamp

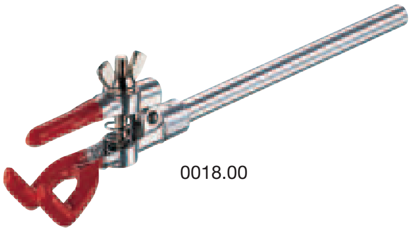
Clamp with rounded jaws of light alloy on a 10 mm. dia. steel shaft. Enables articles from 20 to 55 mm. dia. to be clamped securely, with cork lined jaws.
Total length: 240 mm. Weight: 0.2 kg.

0018.10 Clamp

Clamp

Clamp with diecast lacquered angular jaws on a 10 mm. dia. steel shaft. Enables articles from 10 to 40 mm dia. to be clamped securely, with cork lined jaws.
Total length: 200 mm. Weight: 0.22 kg.

0018.30 Clamp



Clamp

Clamp with overlapping jaws on a 10 mm dia. Steel shaft. Enables articles from 0-40 mm dia. To be clamped securely. Jaws are coated with soft PVC. Length 230 mm. Weight: 0,14 kg.

0018.00 Clamp

Universal Clamp

Clamp with overlapping jaws of lacquered aluminium on a 10 mm dia. steel shaft. Enables articles from 2 to 85 mm dia. to be clamped securely, with cork lined jaws. Equipped with a double-threaded quick-tightening arrangement for ease of use.
Total length: 230 mm. Weight: 0.18 kg.

0018.40 Universal Clamp

Bosshead

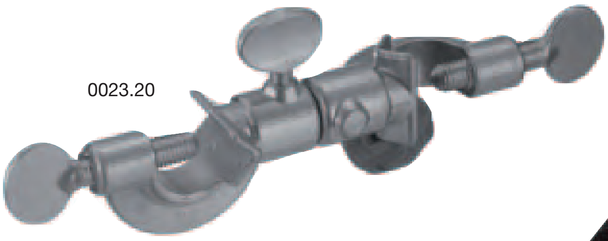
Double Bosshead in lacquered aluminium with two slots at right angles to take round or square rods from 7 to 16 mm dia.
Total length: 130 mm. Weight: 0.18 kg.

0023.00 Bosshead

Universal bosshead

Double Bosshead made of lacquered aluminium, with four slots at right angles to take round or square rods up to 16 mm dia. With 2 angular screws.
Overall length: 55 mm.

0023.10 Universal bosshead



Support rod clamp, rotatable

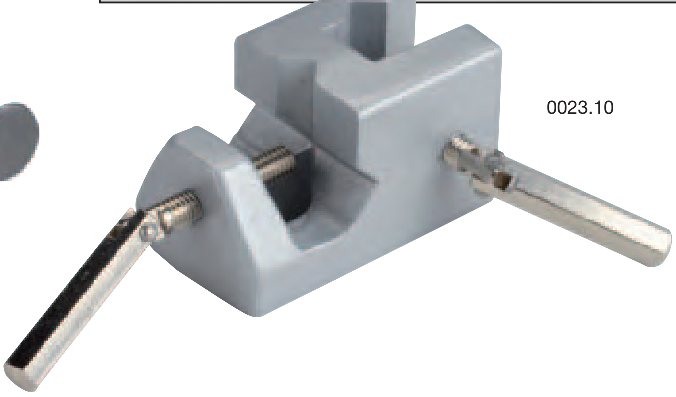
This rotatable double rod clamp is made of pressure cast zinc and finished with lacquer. For support rods from 7-18 mm in diameter. Total length 155 mm. Weight: 0,174 kg.

0023.20 Support rod clamp, rotatable

Support rod clamp with 10 mm diameter hole

Designed for support of equipment using a 10 mm rod. Lacquered, pressure cast zinc. Can be mounted on retort stand rods with a diameter from 7 to 18 mm. Total length: 80 mm. Weight: 0,077 kg.

0028.00 Support rod clamp



Suspension hook

Suspension hook made of lacqured aluminium, hook in nickel-plated brass. Clamps on retorts stand rods from 7 to 16 mm dia.
Total length: 130 mm. Weight: 0.1 kg.

0027.00 Suspension hook

0038.20
0038.10
0038.00

Heating ring

Manufactured of nickel plated steel with a clamp for mounting on retort rod clamps from 6 - 15 mm in diameter. Ring diameter: 60 mm. Total length: 190 mm. Weight: 0,15 kg.

0038.00 Heating ring

Heating ring

As item 0038.00 but with a ring diameter of 80 mm. Total length 205 mm. Weight: 0,22 kg.

0038.10 Heating ring

Heating ring

Manufactured of nickel plated steel with a 10 mm dia. support rod mount.
Ring diameter: 80 mm.
Total length: 240 mm.
Weight: 0,17 kg.

0038.20 Heating ring

Leveling table

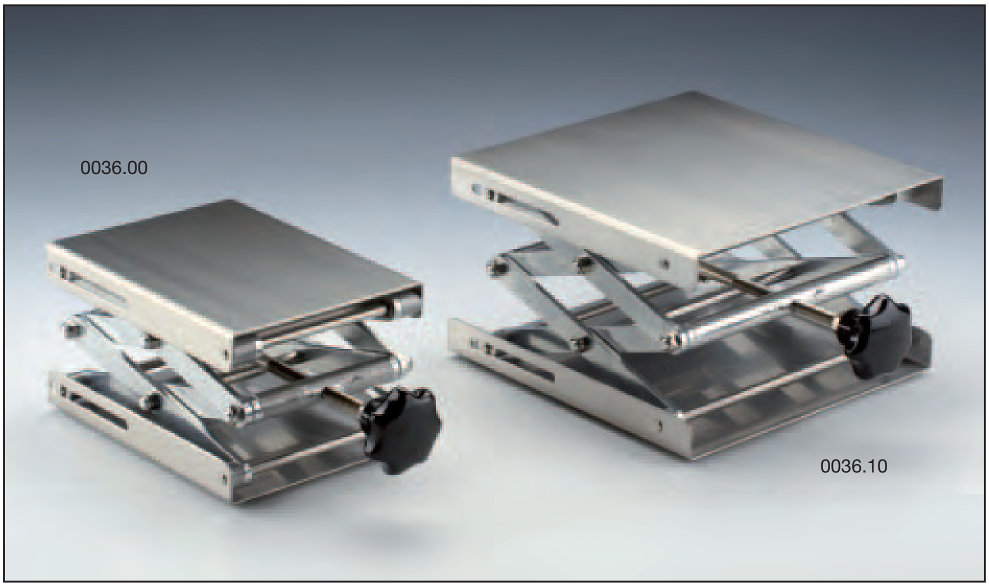
The table size is: 165 x 130 mm. The height variation range is from 62 to 277 mm. It is produced using stainless steel plates with a fast regulating spindle and 8 ea. securing screws. Supplied with rubber pads.
Weight: 1.7 kg.

0036.00 Leveling table

Leveling table

The table size is: 200 x 200 mm. The height variation range is from 62 to 276 mm. It is produced using stainless steel plates. Fast regulating spindle with 8 ea. securing screws and rubber pads. Mass: 2.6 kg. Weight: 2.4 kg.

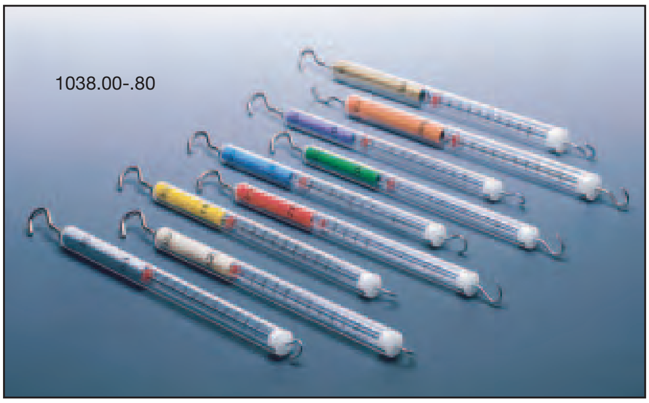
0036.10 Leveling table



Measurements

Dynamometers

The SF dynamometers are available in 9 different ranges covering the range from 0.1 to 100 Newtons. Use the dynamometers to measure an applied force or apply a measured force. These high quality metric dynamometers are precise, durable, and calibrated in Newton.
The graduations are easy to read and the resolution is 2% of full scale.



No.	Range	Resolution	Colour Code	Dimension in mm
1038.00	0-0.1 N	0.002 N	Silver	Ø16 x 265 mm
1038.10	0-0.2 N	0.004 N	Beige	Ø16 x 265 mm
1038.20	0-1 N	0.02 N	Yellow	Ø16 x 265 mm
1038.30	0-2 N	0.4 N	Red	Ø16 x 265 mm
1038.40	0-5 N	0.1 N	Blue	Ø16 x 265 mm
1038.50	0-10 N	0.2 N	Green	Ø16 x 265 mm
1038.60	0-20 N	0.4 N	Violet	Ø16 x 265 mm
1038.70	0-50 N	1.0 N	Orange	Ø20 x 310 mm
1038.80	0-100 N	2.0 N	Gold	Ø20 x 310 mm

Features

Accuracy:
The Dynamometers provide superb linearity and the 100 mm long scales are sharp and clear for excellent resolution.

Durability:
The spring is sealed in the acrylic tube - it doesn't get tangled or overstreched.

Zero adjust:
Easy and accurate zero adjust by means of the knurled screw uppermost on the dynamometer.

Sealed scales:
The scales are inside the acrylic housing so that they won’t wear off.

Colour coded:
Each dynamometer has it's own colour code and the max. range printed on the scale.

Boxed set of dynamometers

Keeps the right dynamometer for the right purpose at hand anytime!
Handy foam-lined box with partitions, holds the entire range of dynamometers 0.1 - 0.2 - 1 - 2 - 5 - 10 - 20 - 50 - 100 Newtons.
The box is also excellent for safe and easy storage.
Box with carrying handle, dimensions: 33 x 27 x 5.5 cm.

1039.00 Boxed set of Dynamometers

1039.10 Foam-lined box only

Measurements, length and volume

Measuring tape, plast

Length: 150 cm. Marked in mm and cm.

1400.00 Measuring tape, plast

Measuring tape, metal

Length: 200 cm. Marked in mm and cm. Metal measuring tape in automatic roll-up housing.

1400.10 Measuring tape, metal

Tape measure, surveyor model

Surveyor model, length 20 m. Centimeter and meter graduation. Tape made of fibre glass armed nylon. Box made of high impact ABS plastic. Auto winding.

1400.20 Tape measure

Ruler

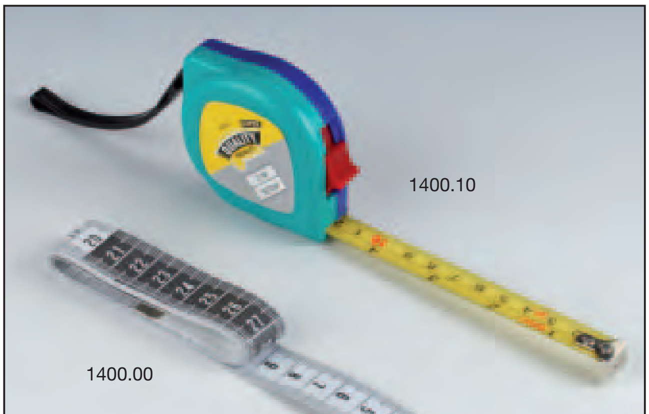
Wood. Length: 50 cm, graduated in millimeters and centimeters. Horizontal reading.

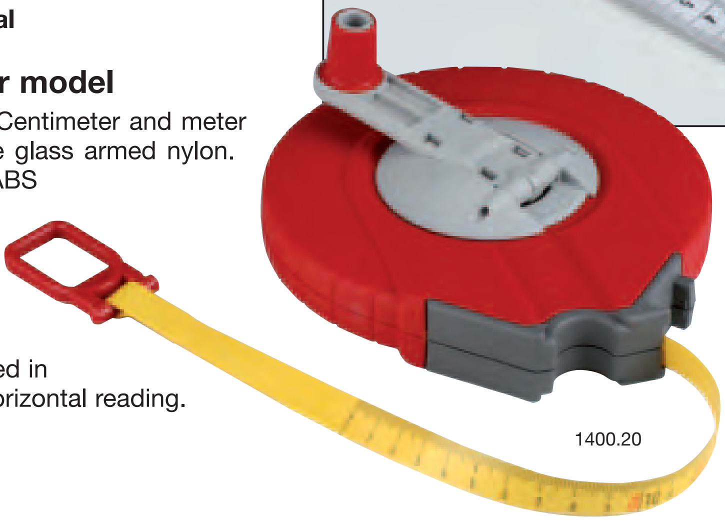
1405.00 Ruler

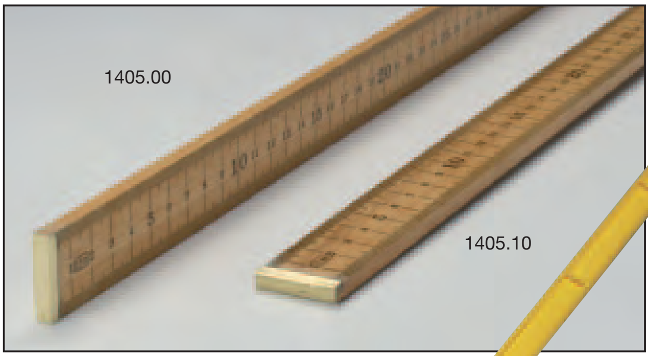
Ruler

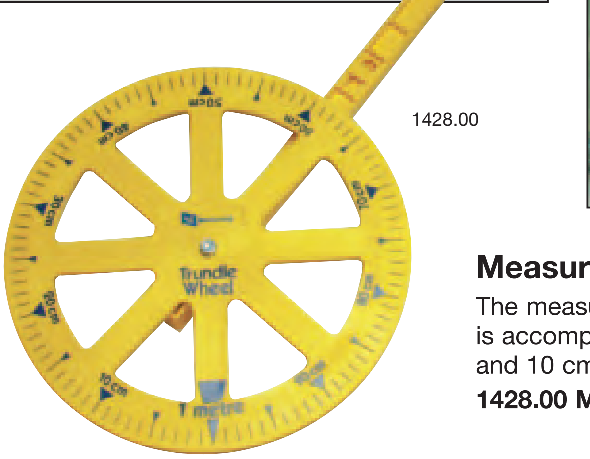
Wood. Length: 1 m, graduated in millimeters and centimeters. Horizontal reading.

1405.10 Ruler









Measuring wheel

The measuring wheel is supplied with a handle, and each rotation is accompanied by a “click” representing 1 meter. Marked in 2 cm and 10 cm intervals.

1428.00 Measuring wheel

Caliper gauge, plastic

Measuring length 130 mm. Overall length 170 mm. Equipped with depth gauge and vernier scale for reading to 1/10 mm.

1440.00 Caliper gauge, plastic

Caliper gauge, steel

Measuring length 120 mm/5 inches, with depth gauge and vernier scale for reading to 1/10 mm.
Overall length 18.5 cm.

1440.10 Caliper gauge, steel

Caliper gauge, stainless steel

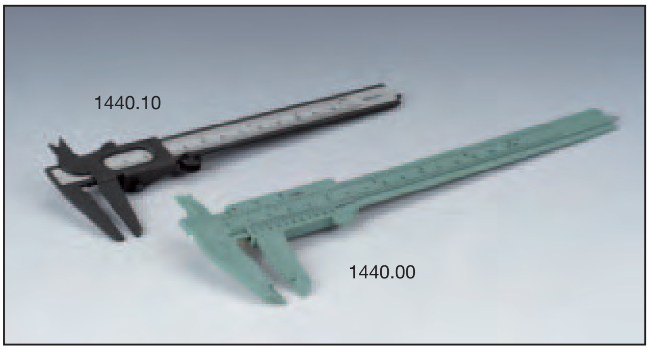
High quality caliper gauge with measuring length 140 mm/5.5 inches. With vernier scale for reading to 1/20 mm, depth of stop and locking system.

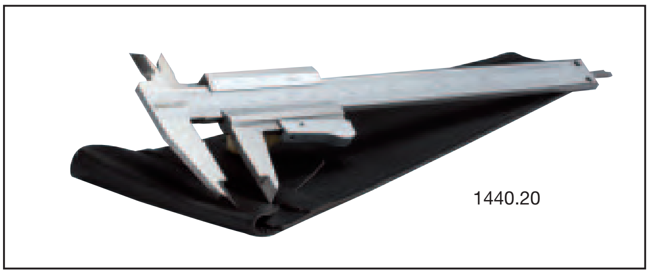
1440.20 Caliper gauge, stainless steel

Micrometer screw gauge

Maximum measuring length 25 mm. Precision 0.01 mm. A precision micrometer with girder section frame, specially hardened and ground screw, locknut and ratchet. Supplied in protective case.

1450.50 Micrometer screw gauge





Liter measuring pitcher

This plastic measuring pitcher is marked in units of volume. There is a marking for each 10 ml. Manufactured in clear, shock resistant polyethylene.

1465.00 Measuring pitcher, ½ liter

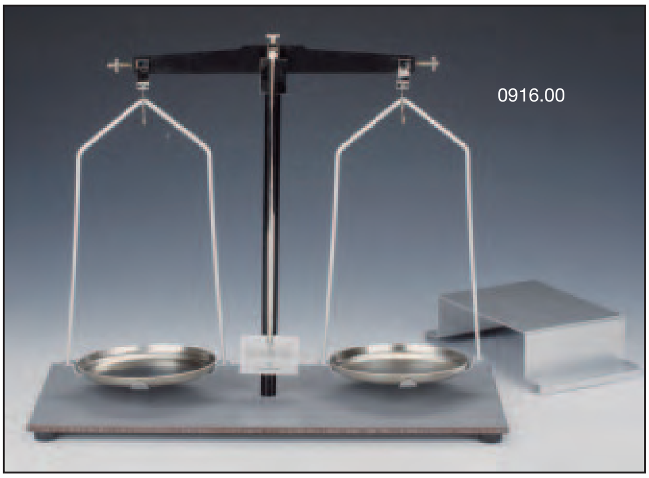
1465.10 Measuring pitcher, 1 liter

Measurements, mass

Beam balance with support stand

This sensitive beam balance is supplied with a support stand. It is provided with a knife edge bearing in hardened steel, a screw adjustment for zeroing, a 28 cm long indicator needle with scale, loose 120 mm diameter weighing pans and a plate for buoyancy experiments. The sensitivity of the balance is 50 mg.
Height: 35 cm, Depth: 20 cm, Width: 40 cm.

0916.00 Balance with support stand



0916.00

Digital scale

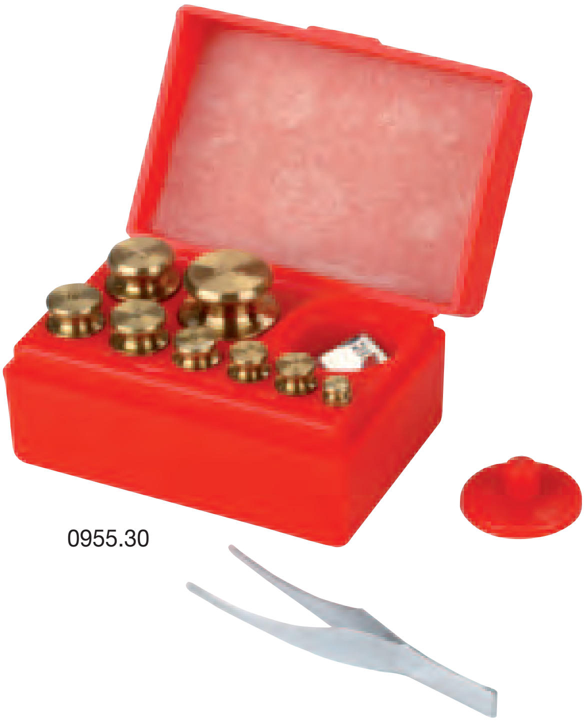
For quick weight measurements indoors or out. Weighing range 0-2 kg (accuracy 0-1 kg/1 g, 1-2 kg/2 g). Battery powered with an automatic power-down feature. The weight is supplied with a 135 x 135 mm weighing plate. Solidly built and suitable for use out of doors. Zeroing possible in the entire weighing range. The weight is supplied without a battery (use 1 ea. 3510.10).

1028.07

Balance masses set

Set comprising 16 masses from 10 mg to 50 g. Supplied complete in a plastic box incl. Nikkelplated forceps.

0955.30 Balance masses set



0955.30

Digital scale

Weighing range 0-200 g with 0,1 g accuracy. Automatic power-down. Battery powered. Batteries included.

1028.15 Digital scale

1028.15

Specific gravity

Specific gravity cubes

Dimensions 10 x 10 x 10 mm. For illustration of the specific gravity of different materials. The set comprises of six different materials: Al, Fe, Zn, Cu, Pb and wood. Supplied in a plastic box.

1500.00 Specific gravity cubes

1500.00
1cm³

Specific gravity cylinders

6 different materials: Fe, Al, Pb, Zn, wood and cork. 3 of the cylinders have the same weight i.e. Al, Pb and Zn (41 gr.). Two of these cylinders have the same diameter. The remaining cylinders have different volumes and shapes. The cylinders are easy to measure. Supplied in a plastic box.

1510.00 Specific gravity cylinders

Specific gravity cylinder

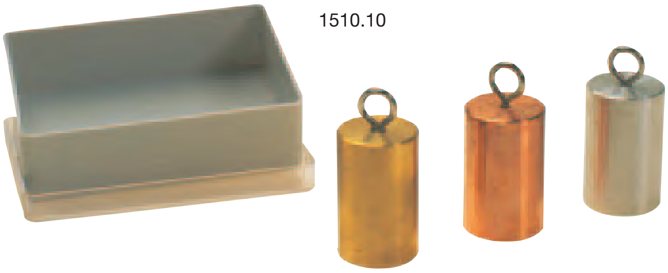
Brass cylinder for determining specific gravity and measuring volumes. Height 28 mm.

1510.80 Specific gravity cylinders

Specific gravity cylinders

3 different materials with the same volumes.
Al, Cu and brass.
Diameter 20 mm, height 31.5 mm.
Supplied in a plastic box.

1510.10 Specific gravity cylinder



Specific gravity cubes

6 different materials each in three different sizes.
Delivered in a plastic box.

1500.10 Specific gravity cubes

Pycnometer, calibrated

This device is used to measure the density of fluids. It is sometimes called a specific gravity bottle. Manufactured of glass with a tightly fitting ground glass stopper with a fine hole in it. Calibrated. Volume: 50 ml.

520.00 Pycnometer, calibrated

1520.00
1520.10

Pycnometer, uncalibrated

The same device as 1520.00 but uncalibrated. Volume: 25 ml.

1520.10 Pycnometer, uncalibrated

Areometer

A device for finding the specific gravity of liquids. Density range: 0.700-1.000 g/cm^3. Accuracy 0.005 g/cm^3. Total length: 300 mm.

1530.00 Areometer

Areometer

Density range: 1.000-2.000 g/cm^3. Accuracy 0.010 g/cm^3. Total length: 300 mm.

1530.10 Areometer

Areometer

Density range: 0.750-0.840 g/cm^3 with thermometer.

1530.20 Areometer

Areometer with thermometer

For determination of the salt content of seawater. Temperature table supplied. Total length: 265 mm.

1530.30 Areometer with thermometer

1530.90
1530.20
1530.30
1530.10

Alcohol meter

1 - 100 vol %. Total length: 300 mm.

1530.90 Alcohol meter

1485.40

Demonstration stopwatch

Easy to read from a remote distance.
Quartz clockwork with dials.
Range 0-60 sec 0-60minutes.
Diameter 110mm, weight 375 ,g.
Supplied with battery

1495.20 Demonstration stopwatch

1495.20

Digital stopwatch, Phoenix

The stopwatch has an LCD-display with 6 ea. 8.5 mm/7 mm digits. Functions: start/stop/reset, addition, intermediate times /splits. Double measurement of two times intervals closely following one another. Standard clock (2 x 12 hours AM/PM). Date.

1485.40 Digital stopwatch, Phoenix

Stopwatch

Seconds scale 0-30 s. Minute scale 0-15 min. Accuracy 1/10 s. Three function buttons for start, stop and reset.

1485.00 Stopwatch

1485.00

Digital stopwatch

Low cost digital stopwatch with LCD display with 5 mm high digits. Functions: start/stop/reset, addition, intermediate times/splits, standard time and date.

1485.15
Digital stopwatch

1485.15

Digital countdown clock

LCD digital countdown clock with 35 mm high digits. Alarmfunction.

1492.05 Digital countdown clock

1492.05

Student timer

- Time measurements from 0.03 ms to 27 hours
- Measurement precision 0.01 ms
- Start/stop by connecting microphones (2485.10), photocells (1975.50) or ordinary 4 mm safety jack leads
- Manually controlled stopwatch option
- Simple operation – excellent for student experiments

Particularly well-suited for experiments such as:

- The free fall
- Speed of sound

2002.60

Technical specifications:

Display: 5 digit LED with floating decimal point

Resolution: 0.01 ms

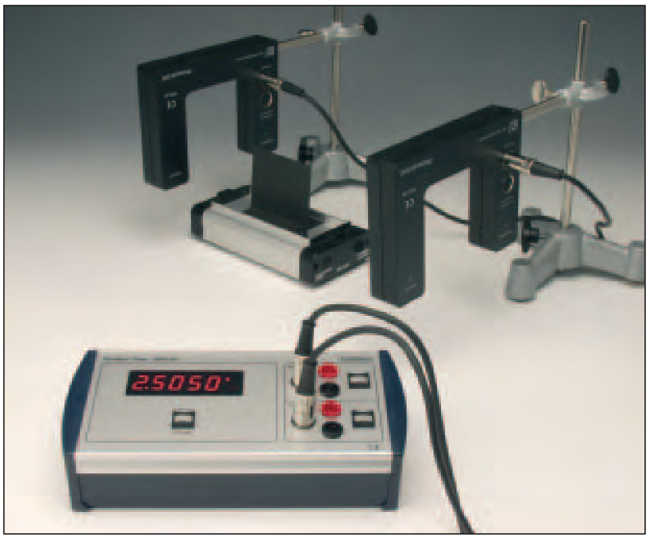
Inputs: DIN-5 pole connectors for photocells and microphones, 4 mm safety jack leads for free fall experiment and other apparatus

Power: 6 ea. AA batteries or power-line adapter (incl.)

2002.60 Student timer

Photocell unit

The unit is suitable for the measurement of pendulum periods, time interval measurements for experiments on an air track, measurements of periods of rotation, etc. The unit consists of a photocell which is illuminated via a one millimeter aperture by light from a light emitting diode. A red LED (light emitting diode) is provided next to the light source to indicate that the light source is on. A green LED near the photocell indicates when the receiver is illuminated. The photocell unit is provided with two 6-pole DIN-connectors for connection to the electronic counter no. 2002.50 or 2002.60 and serial connection to additional photocell units, when signals are to be sent to the same input connection on the counter. The unit is manufactured in rugged plastic with threads for horizontal or vertical mounting using the 10 mm diameter mounting rod provided. A connector cable for the electronic counter is also provided. The maximum distance between the photocell and the light source is 90 mm. Dimensions: B x H x D: 160 x 120 x 28 mm. Mass: 450 g.



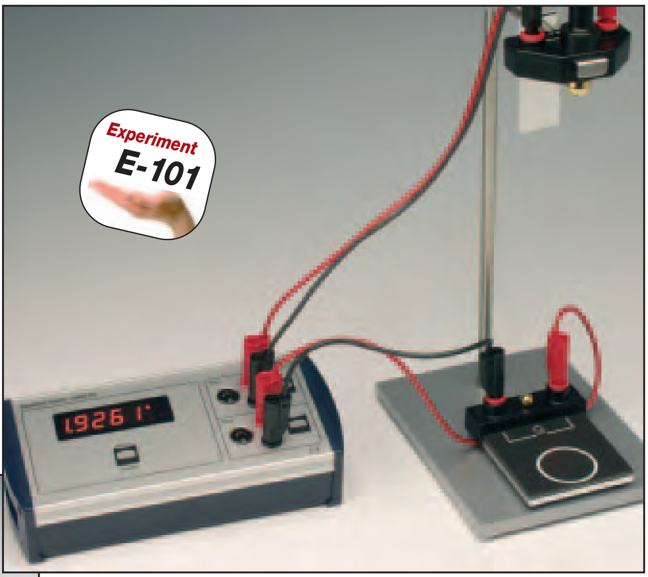
1975.50 Photocell unit including cable and mounting rod

1975.50

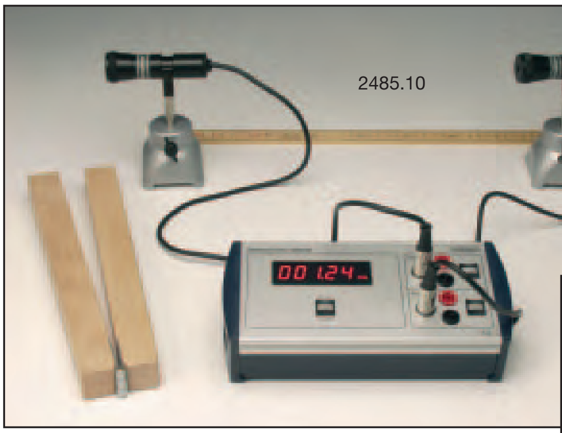
Free fall apparatus

This apparatus is designed to be used with an Electronic Counter to determine the fall time for a freely falling steel ball. The apparatus consists of a release mechanism which also acts as the start switch, a strike plate which acts as the stop switch and gold-plated steel balls. The release mechanism is provided with two dia. 4 mm banana plug connectors for connecting safety dia. 4 mm banana plug leads to the Counter start switch input. A 10 mm diameter mounting rod for supporting the mechanism on a lab stand is supplied. The strike plate is also provided with two dia. 4 mm banana plug connectors for attaching this unit to the Counter stop input.

1980.10 Free fall apparatus



1980.10


2485.10

Experiment
E-102

Microphone

The microphone is well-suited for the measurement of sound frequencies, the speed of sound and the recording of sound for Fourier transformation.
The sensitive microphone is very small and therefore very suitable for measurements of sound interference.
It is supplied with a one meter cable with a 3-pole DIN connector which can be connected directly to the electronic counter type 2002.50 or student timer type 2002.60. The microphone can also be connected to an oscilloscope or other measuring instrument via a type 2515.60 power supply. The frequency range is 20-20.000 Hz. Supplied with 10 mm diameter support rod. Dimensions: Length 105 mm, greatest diameter 30 mm.

2485.10

2485.10 Microphone without stand

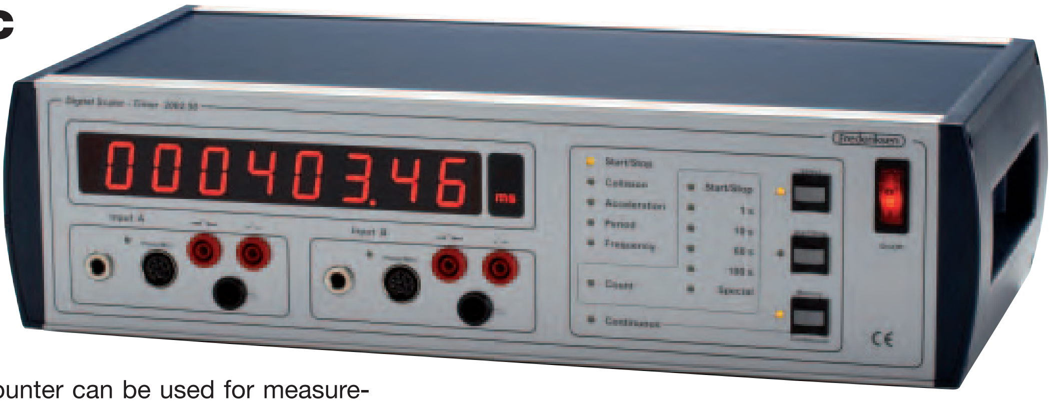
2482.00

Clapper board

This clapper board is ideal for producing the sharp sound pulse required for measuring the speed of sound. Produced with two hinged hardwood blocks.
Dimensions: 27 x 50 x 300 mm. Mass: 280 g.

2482.00 Clapper board

Electronic counter



- Multiple function capability.
- Microprocessor controlled.
- User-friendly.
- High accuracy.

This microprocessor controlled eight-digit counter can be used for measurement of time intervals, periods, revolutions per second, frequency, pulses, etc. The indicator shows the units of measurement, and the display indicates the input terminal being used. Start/stop terminals for attachment of microphones, photocells, free fall equipment, etc. are provided. There is a connector for attachment of a GM-counter for measurements of radioactivity with selectable gate times. The counter is provided with an easy-to-read LED display and a logically arranged control panel making the apparatus highly suitable for demonstration experiments as well as for student lab exercises. Memory is provided for storing measured values as well as an RS-232 port for connection to a computer.
A computer program for analysis of the collected data is provided. Time intervals down to 1 millisecond, and frequencies up to 2 MHz can be measured.

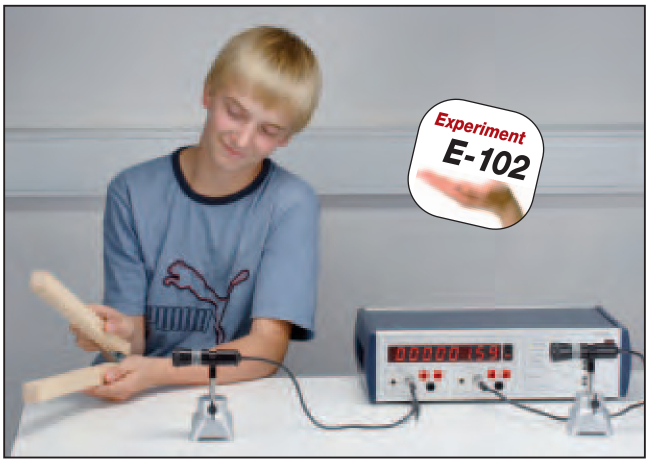
Graf Datalyse Compatible

Technical Specifications

General:	8 digit 7 segment LED 25 mm high
Power supply:	230 VAC, 50 Hz
Time measurement, start-stop:	from 0.01 ms to 100 s, resolution 0.01 ms
Collisions: passage times, min/max:	0.01 ms/100 s, resolution 0.01 ms, but 1 ms for passage times over 10 s. Memory storage for 4 values, 2 from each photocell or 3 values from one and one value from another.
Acceleration: passage times min/max:	0.01 ms/100 s, resolution 0.01 ms, but 1 ms for passage times over 10 s. Memory storage for passage time A, passage time B, and the time from A to B.
Period:	From 0.01 ms to 10 s.
Memory storage:	50 values
Frequency:	0.01 Hz - 1 kHz, resolution 0.01 Hz 1kHz - 10 kHz, resolution 0.1 Hz 10 kHz - 2.5 MHz, resolution 1 Hz
Counter:	1 count - 10 million counts, 1 count resolution
Measurement times:	1 S, 10 s, 60 s and 100 s.
Gate times:	2.5 MHz / 0.4 ms
Memory storage:	50 values
Dimensions:	LxHxW: 405 x 116 x 205 mm. 3.7 kg

2002.50 Electronic counter

Measurement of pendulum period.



Measuring the speed of sound.

Water powered air pump

Polypropylen plastic pump. Connection threads for 1/2" and 3/4" pipes. Sealing fitting with “O”-ring. Supplied with a reverse flow valve. Total length: 270 mm.

0690.20 Water powered air pump

Water powered air pump

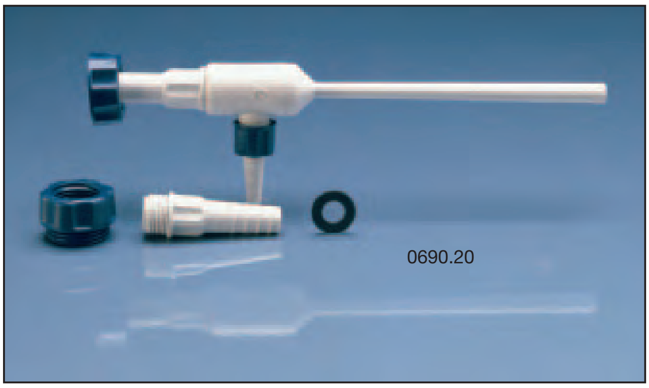
Chrome plated brass with sealing fitting with 1/2" pipe thread. Supplied with reverse flow valve. Conical tube connection fitting 11-12 mm. Total length: 140 mm.

0690.30 Water powered air pump

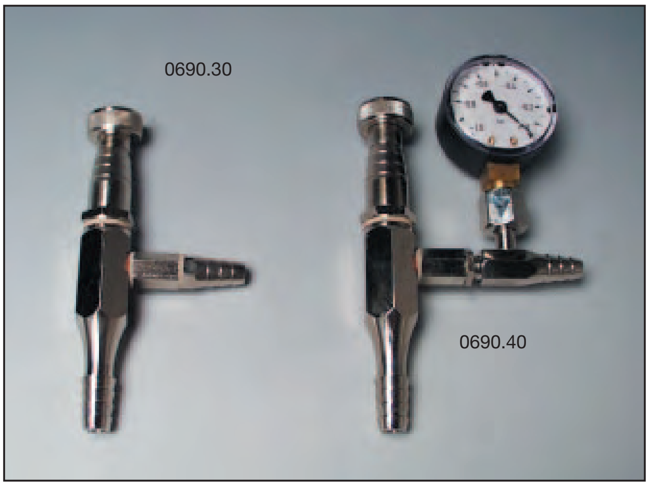
Water powered air pump

Manometer of chrome plated brass with a scale from 0-1 bar. Accuracy 0.025 bar. Also as 0690.30. Total length: 160 mm.

0690.40 Water powered air pump



0690.20



0690.30

0690.40

Vacuum pump

Electric rotary vane vacuum pump. The pump is equipped with an automatic gas ballast valve which will open in case of condensable steams suction. In such cases the gas ballast valve will operate to avoid condensation inside the pump and evacuate steam or fumes including oil.

Technical data:

Mains operated:	220 V AC, 50 Hz
Free air displacement:	27 l/min.
Ultimate vacuum:	5 x 10^{-1} Pa
Motor power:	1/3 HP
Fittings sizes:	1/4”G
Oil:	220 ml
Net mass:	12.5 kg
Dimensions L x W x H:	336 x 123 x 255 mm

0695.25 Vacuum pump

0695.25

Oil for vacuum pump

For refilling or replacing the operating oil in Vacuum Pump 0695.20

0695.30
Vacuum Oil 1 liter

0695.30

0700.10
0715.00

Vacuum meter

The meter scale goes from 0 to 1.0 bars at 0.05 bar intervals. The meter diameter is 50 mm. It is supplied with a tube connector fitting.

0700.10 Vacuum meter

Hand-powered vacuum pump

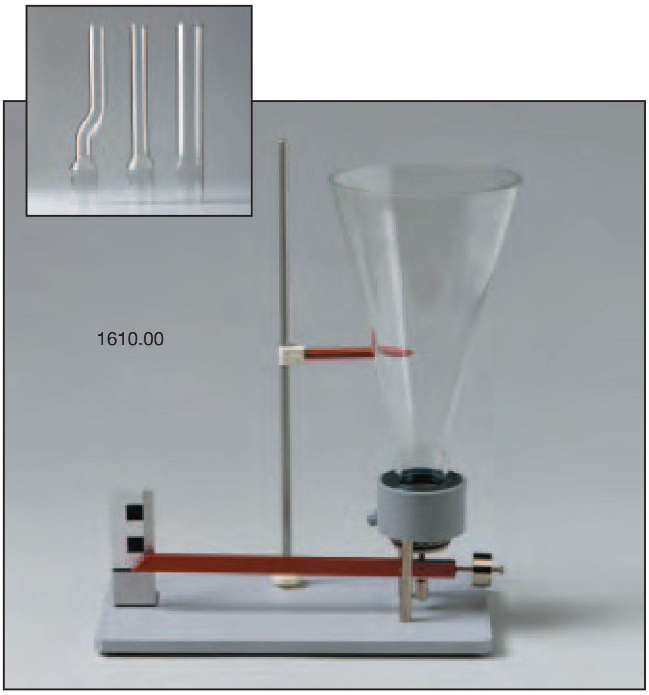
This hand-powered vacuum pump uses a piston. It is supplied with a one-way valve and tube connection fitting. Ultimate vacuum down to 0.1 atm.

0715.00 Hand-powered vacuum pump

Vacuum grease

Silicone grease for high vacuum applications. The grease is approved for temperatures from -40 to +250 degrees C. The can contains 60 grams.

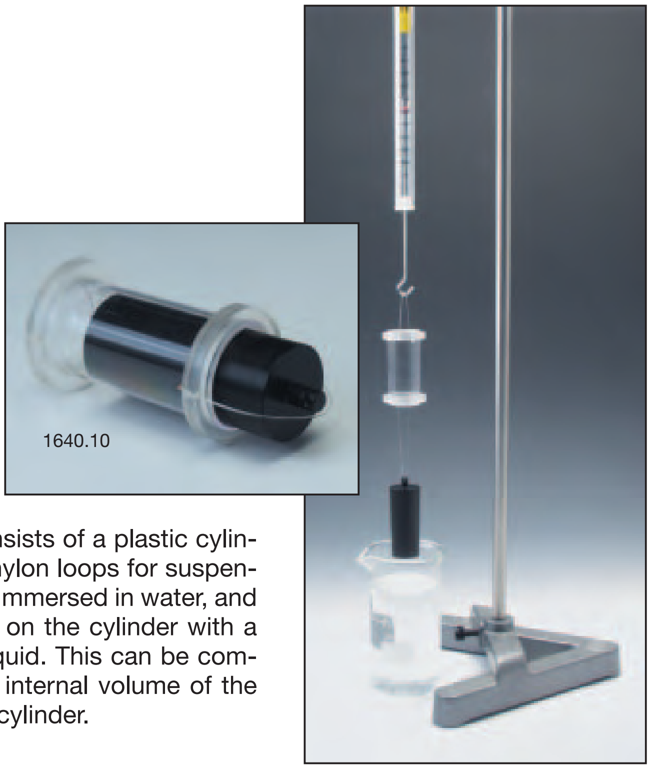
0710.20 Vacuum grease



Pascals vases apparatus

These vases are used to show that pressure in a liquid is a function of depth only. The vases are four differently shaped glass vessels which may be attached to a base which has a diaphragm sensitive to pressure and connected to a dial. Bottom plate with support: 235 x 130 mm, height incl. glass tube: 290 mm. Pressure sensor with scale.

1610.00 Pascals vases apparatus



Archimedes cylinder set

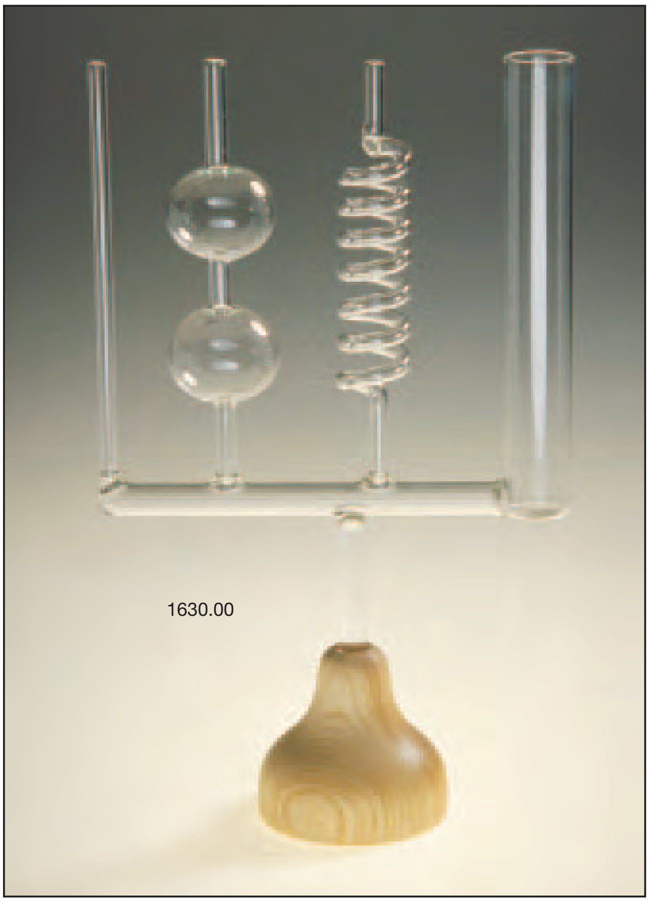
This equipment is for demonstrating Archimedes law. It consists of a plastic cylinder supplied with an eye and a transparent container with nylon loops for suspension on a newton meter or a balance. The plastic cylinder is immersed in water, and the buoyancy of the water opposes the gravitational force on the cylinder with a magnitude corresponding to the weight of the displaced liquid. This can be compensated for by filling up the container with water, for the internal volume of the container corresponds exactly to the volume of the plastic cylinder.

1640.10 Archimedes cylinder set

Liquid level apparatus

To show that the level of liquid in connected vessels is constant regardless of the size or shape of the vessels. The tubes are mounted on a plastic base, diameter 120 mm. Overall height 230 mm.

1630.00 Liquid level apparatus



Overflow container, archimedes' beaker

A body is immersed in the cylindrical beaker. Diameter: 37 mm, height: 147 mm. The displaced liquid runs out through an overflow tube and can be collected. Used to demonstrate Archimedes law.

1645.00 Overflow container, archimedes' beaker

1732.00
1730.00

Air pressure demonstration jar

A glass cylinder 120 x 120 mm high with ground bottom edge for use on a pump plate, and flange on top for attaching a rubber membrane. Including Rubber Membrane.

1730.00 Air pressure demonstration jar

Rubber membrane

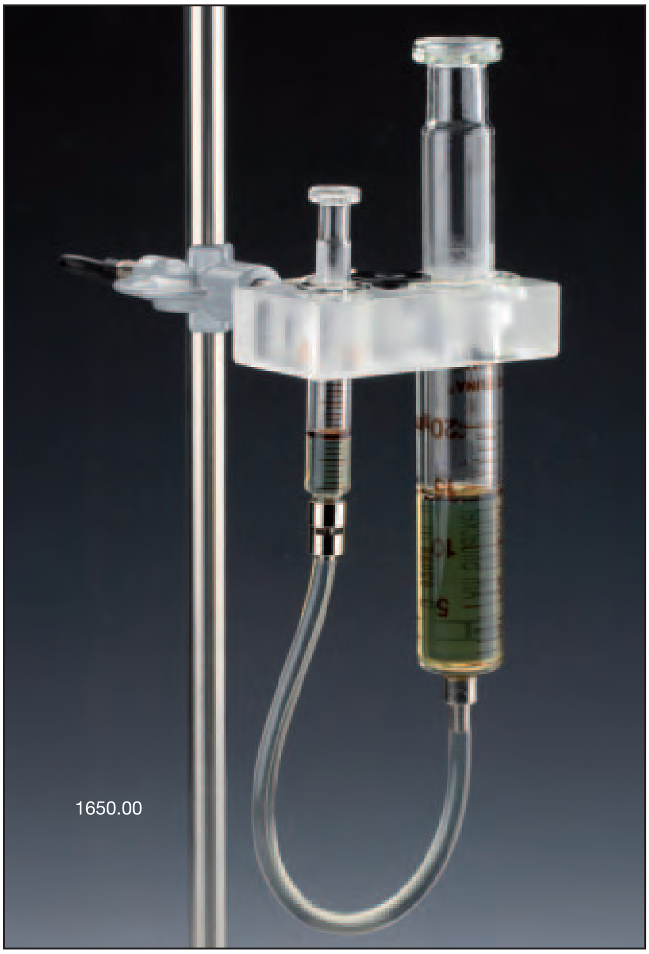
Dimension: 220 x 220 x 0,2 mm

1625.10 Rubber membrane

Collapsible metal can

To demonstrate the pressure of the atmosphere.

1732.00 Collapsible metal can



Hydraulic press

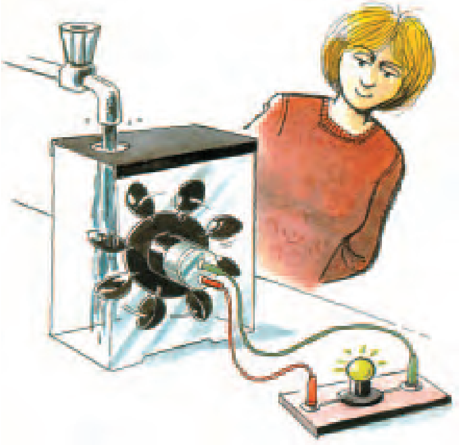
The device consists of two glass syringes of 2 and 20 ml. They are connected with a short PVC tube. Pressing one cylinder causes the other to move. The distances which the cylinders move are inversely proportional to the area ratios.

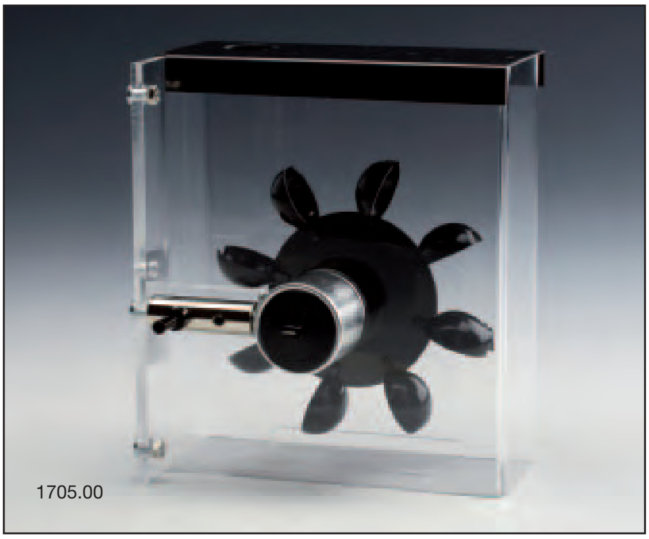
1650.00 Hydraulic press

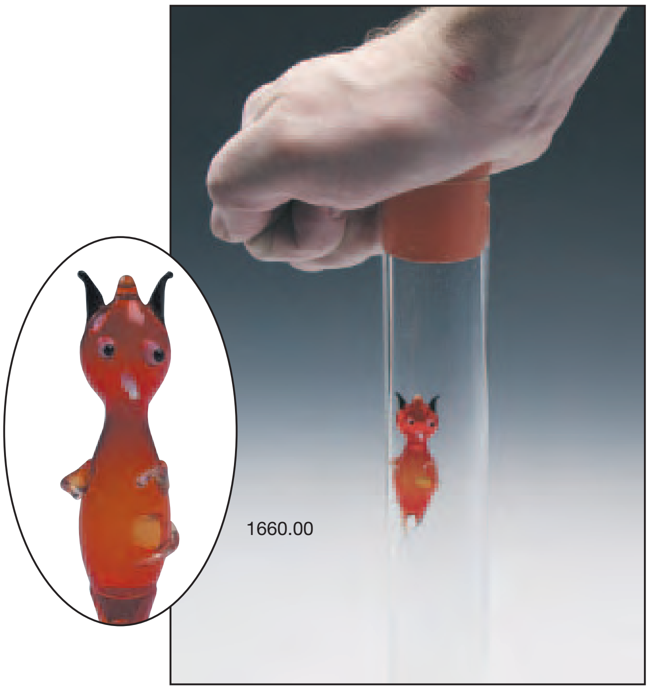
Pelton turbine with generator

Assembled, operational model which by means of water or air jets is capable of producing electricity to light a filament lamp. Turbine housing of plexiglass. Turbine wheel of black plastic. As generator is used an ordinary 6 V AC bicycle dynamo.
Turbine housing: H. 195 mm, W. 170 mm, D. 100 mm.

1705.00 Pelton turbine with generator



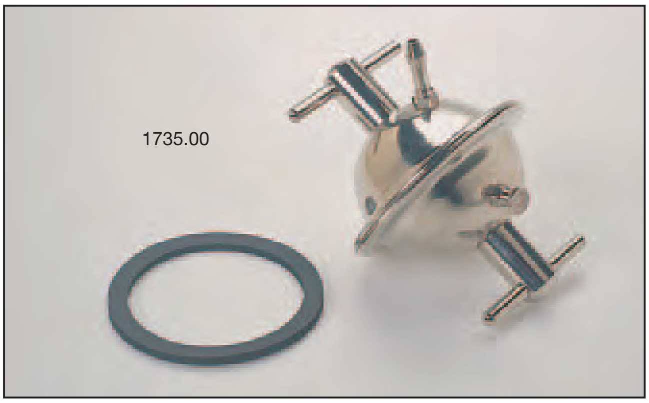

1705.00

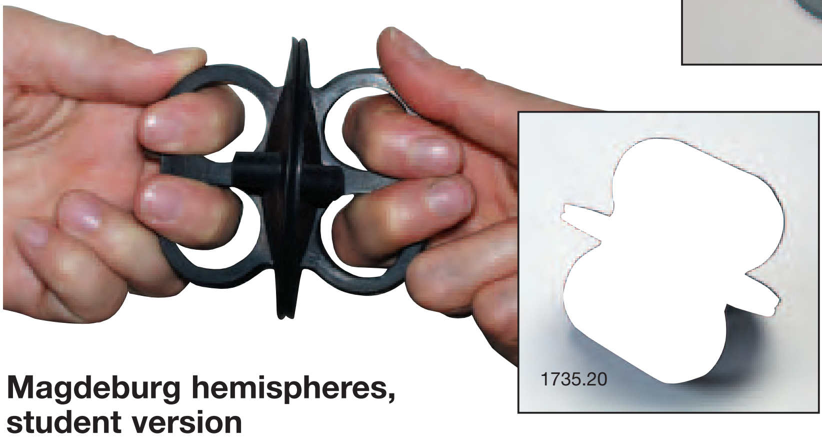

1660.00

Cartesian devil

Used to demonstrate liquid pressure. Hollow glass figure, height ca. 45 mm.

1660.00 Cartesian devil


1735.00


1735.20

Magdeburg hemispheres, student version

Made of black rubber. Package with 4 pairs.

1735.20 Magdeburg hemispheres, student version

Magdeburg hemispheres

For demonstration of the pressure exerted by the atmosphere. Made of chrome plated brass with rubber gasket. Provided with venting screw and connector with non-return valve. Diameter 110 mm, mass 711 g.

1735.00 Magdeburg hemispheres

Gasket for 1735.00

Rubber Gasket

1735.01 Gasket for 1735.00

Manometer

This simple, user-friendly manometer has a digital read-out display which shows the measured pressure directly in kPa. Measuring range: 0-200 kPa with an uncertainty of +/-2%. Connection directly to a tube connection on the front panel is possible for tubing with dia. 5-7 mm. Power supply: 6 ea. 1,5 V AA batteries or line adapter 3550.10-3550.20 (included).

1770.00 Manometer

1770.00
Manometer 1770.00
Frederiksen
99.9
kPa
0 - 200 kPa
9 - 12 V DC
On/Off
Dry air only

Dasymeter

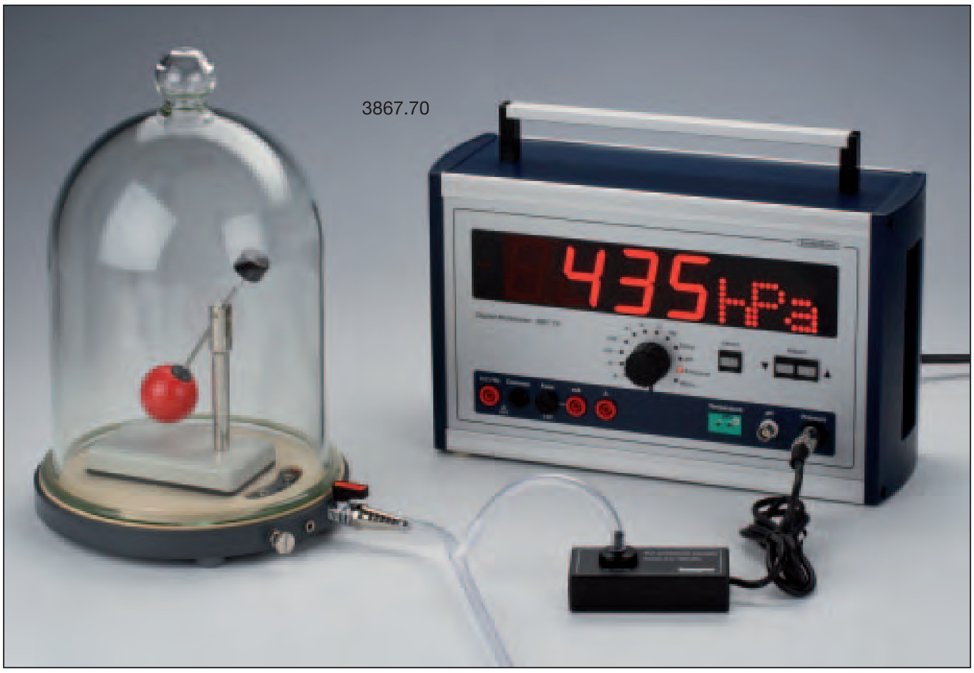
For demonstration of air buoyancy when placed in a vacuum receiver. Hollow plastic ball suspended on beam with adjustable weight.
Dimensions: H. 135 mm, L. 120 mm, W. 65 mm.

1740.00 Dasymeter

Demonstration multimeter

Manometer · pH-meter · thermometer · multimeter

To maintain maximum student interest in a demonstration requires student involvement.
This new Demonstration Multimeter ensures student interest by allowing the students, no matter where they are in the class room, to see the instrument readings first hand.
Your students no longer have to just take your word for it, they can see the readings themselves.
Designed especially for education, this Demonstration Multimeter has eight very significant features.



3867.70 Demonstration multimeter.

1. Extra large (45 mm high) digits
And since the digits are LEDs (Light Emitting Diodes) they can easily be seen from the back of the classroom (up to 8 meters).

2. Extra large units symbols
The units symbols (hPa, V, pH, °C, A, Ω and Hz) ensuring that no student is confused as to what is being measured. A bright 30 mm LED matrix makes this possible. Switching functions automatically set the correct units symbol.

3. Autoranging
The measuring range is automatically matched to the measured value.

4. One instrument for both chemistry and physics
This particular instrument will be used day after day since it not only measures the usual electronic quantities such as volts, amps and ohms, but it also measures pressure pH and temperature from minus 50 to plus 1200 degrees Celsius.

5. Back facing teacher's display
In most cases the teacher stands behind the measuring instrument, making the reading af the display somewhat awkward. A second display is available for the back of the instrument. Its 14 mm high digits ensure that the teacher can read the value even when a few meters away from the instrument.

6. Computer Output
An RS 232 C output makes it a simple matter to connect your computer to the experiment. The output is optically isolated from the instrument input so there is no danger of damaging the computer when working with high voltages. Since the output is controlled by a microprocessor, using standard data formats, connection to a computer is straightforward.

8. Graphing program available
For those cases where it is desirable to plot a function versus time (such as temperature during a chemical reaction) a program is available to take measurement at specific time intervals and then plot the points on a graph. This graph may also be plotted on a printer.

IM-131410
Air pressure sensor
Range: 0 to 1300 hPa.
IM-131510
Air pressure sensor
Range: 500 to 7000 hPa.

Pressure sensors

The sensors are connected to the DIN-connectors of these instruments. Then measurements can commence. The instruments make their own identification of the sensor which is connected. The sensors are supplied with a tube fitting to which plastic tubing with an internal diameter of 5 or 6 mm can be connected.

Low pressure sensor:
Measuring range: 0-1300 hPa
Accuracy: 1%
IM-1314.10 Pressure sensor

High pressure sensor:
Measuring range: 500-7000 hPa
Accuracy: 1%
IM-1315.10 Pressure sensor

1786.00

Barometer, mini

1771.00

For the measurement of barometric pressure in millibars and millimeters of mercury with an adjustable dial to record the previous observation. The diameter of the barometer is only 67.5 mm which makes it possible to put it inside the “Glass with tube connector” product 1786.00 to simulate over and under pressures in the glass container. The barometer can be calibrated using an adjustment screw.

1771.00 Mini barometer

Student bell jar

This bell jar provides a vacuum chamber for students to perform many experiments: Watching a balloon expand. Warm water boil as air is pumped from the chamber. Observing that a suction cup no longer sticks when the jar is evacuated. Hand-Powered Vacuum Pump no. 0715.00 or a 100 ml plastic syringe and valves can be used for evacuating the Jar. To measure the pressure in the Student Bell Jar no. 1771.00. Barometer can be used since it fits into the Bell Jar.

1786.00 Student bell jar

1785.10

1780.00

Air pump plate

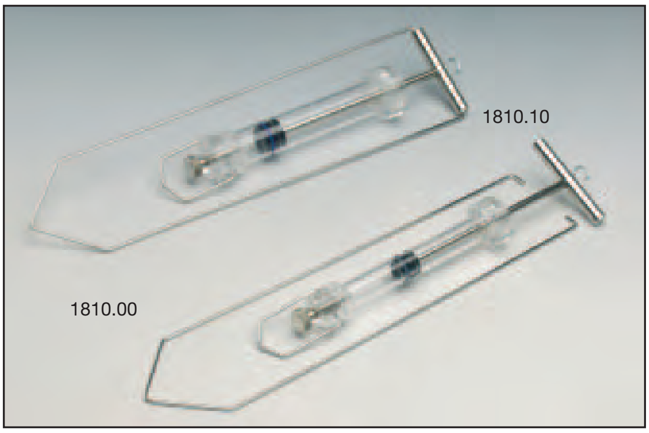
This plate is used with a bell jar for demonstration experiments involving low pressure. The plate is made of PVC and supplied with rubber feet. There is a vacuum connection fitting with a valve and a thumb screw for the return air. Two standard 4 mm jack connectors are provided with 4 mm jack connections available inside the jar. Tube fitting diameter: 10 mm. Plate diameter: 235 mm, height: 40 mm, mass: 1.3 kg.

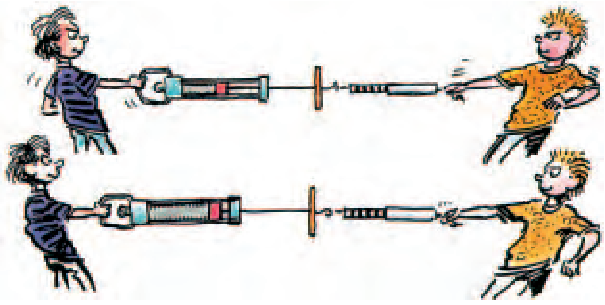
1780.00 Air pump plate

Bell jar with knob

Used in conjunction with pump plate no. 1780.00 for the production of vacuum. Arranged in heavy glass with ground flange. Diameter 180 mm, height 250 mm.

1785.10 Bell jar with knob

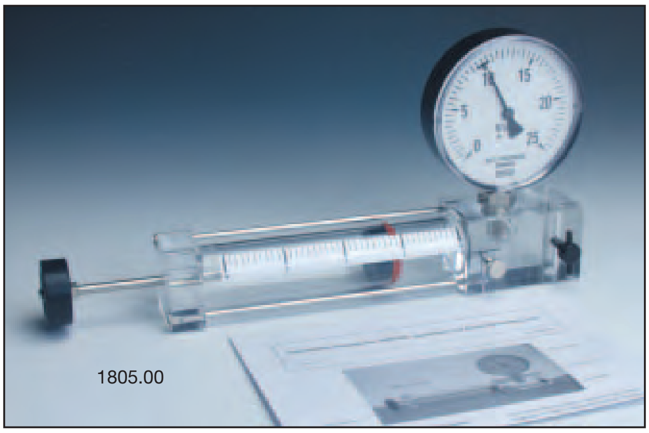




Plastic cylinder with Piston

For demonstration of the relation between volume and pressure at constant temperature (Boyle-Mariotte). The cylinder is graduated and provided with a 1 cm² piston as well as strap and hook, allowing it to be acted on by a dynamometer.

1810.00 Plastic cylinder with Piston 1 cm²
1810.10 Plastic cylinder with Piston 2 cm²



Boyle-Mariotte apparatus

This device is used to demonstrate the connection between pressure and volume at constant temperature. The apparatus consists of a graduated cylinder with a piston. The cylinder acts upon a manometer via a narrow passage. The cylinder is supplied with a screw valve. The manometer diameter is 100 mm. The length of the apparatus is 350 mm.

1805.00 Boyle-Mariotte apparatus

Experiment
E-201

1876.05
000
POWER
ANEMOMETER
AVM-702
ANEMOMETER VANE PROBE

Wind speed meter, digital

This electronic wind speed meter meter has an easily readable digital display. The instrument can display wind speeds directly in km/hour, m/s, knots or feet/minute. The anemometer itself is mounted with low-friction ball bearings inside a protective housing. A 110 cm long cable connects the anemometer unit with the readout unit where the wind speed can be read directly in the units selected. The wind speed data is updated 2.5 times per second. Anemometer operation is independent of orientation.

Technical specifications:

Measuring range	Resolution
0.8 - 30.0 m/s	+/- 0.1 m/s
2.8 - 108 km/h	+/- 0.1 km/h
1.6 - 58 knots	+/- 0.1 knot
160 - 5900 feet/minute	+/- 10 feet/min
Accuracy	+/-3% of full scale, +/- 2 digits
Power supply	1 ea. 9 V block battery

1876.05 Wind speed meter, digital

Mechanics

Centre of gravity plates

Set consisting of 2 aluminium plates, approx. 250 mm long. Equipped with holes for suspending in corners and centre of gravity, with marks for the centre of gravity lines. For suspension the handle with pin no. 1905.10 may be utilized.

1900.00 Centre of gravity plates

Demonstration balance

For demonstration of the weight principle and momentum. Made of nickel-plated brass and equipped with 30 holes numbered from the middle for suspension of weights.

1905.00 Demonstration balance

Handle with pin

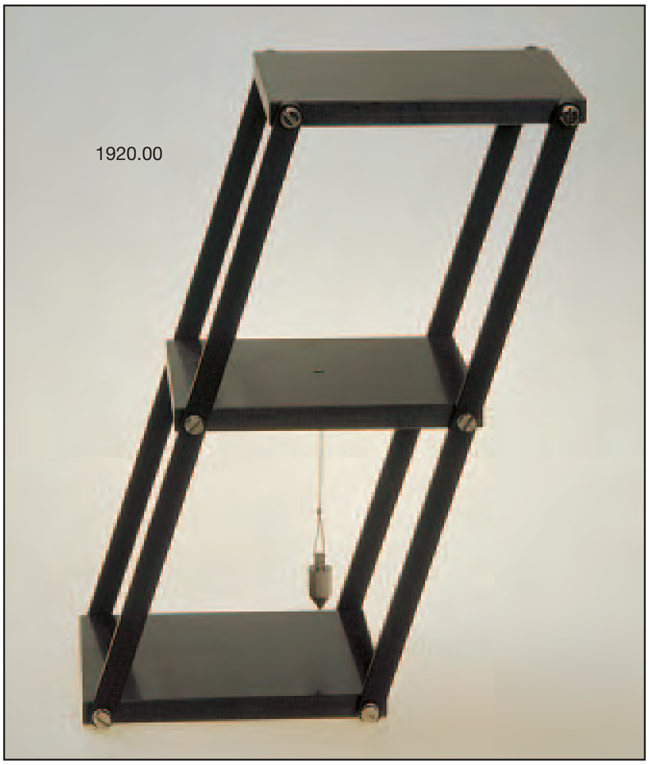
For suspension of no. 1905.00 and 1900.00.

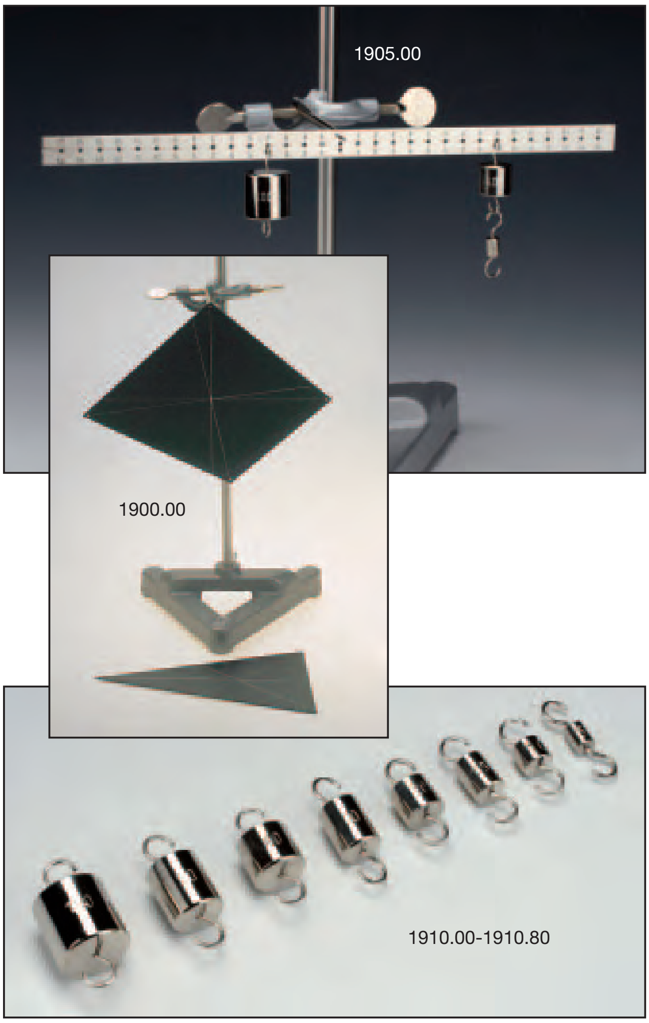
1905.10 Handle with pin

Weights with hooks

Used in conjunction with demonstration balance no. 1905.00, made of nickel-plated brass with stamped mass indication.

1910.00	**Mass**	**100 g**
1910.10	**Mass**	**60 g**
1910.20	**Mass**	**50 g**
1910.30	**Mass**	**40 g**
1910.40	**Mass**	**30 g**
1910.50	**Mass**	**20 g**
1910.60	**Mass**	**15 g**
1910.70	**Mass**	**10 g**
1910.80	**Mass**	**5 g**





0960.40
0960.30
0960.20
0960.10

Iron weights

These calibrated weights are made of galvanized iron. They are provided with an eye-hook, and they are marked with the value of the mass.

0960.10 Mass 500 g, 45 mm
0960.20 Mass 1000 g, 60 mm
0960.30 Mass 2000 g, 75 mm
0960.40 Mass 5000 g, 100 mm

Stability apparatus

To illustrate how stability depends upon the location of the center of gravity with respect to the base. The position of the centre of gravity is well defined and can be changed easily. Materials: Enamelled steel bars with plastic centres. Base: 100 x 120 mm, Height: max. 260 mm.

1920.00 Stability apparatus

Friction block

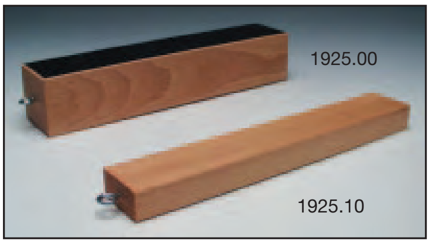
This wooden block with a square cross section has surfaces with rubber, felt, sandpaper and wood. Supplied with a hook at one end. Size: 60 x 60 x 300 mm.

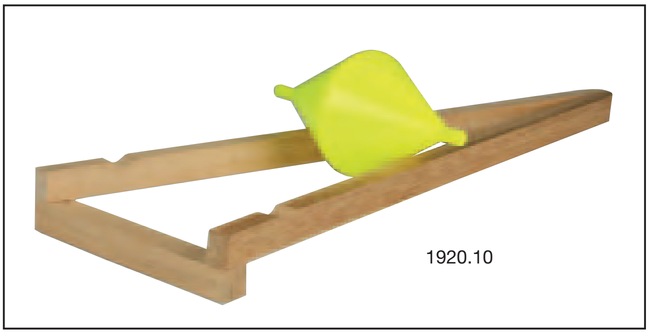
1925.00 Friction block

Friction block, area

This item is for demonstration of the dependence of friction upon area. Two different areas can be used with the same mass. Supplied with a hook at one end.
Size: 300 x 50 x 26 mm.

1925.10 Friction block, area





Double cone with ramp

In contrast to what one expects, the double cone appears to roll uphill when placed at the bottom of the ramp. But is this also the case? Stimulate your students' curiosity with this simple, classical paradox - and try it with your colleagues in the teachers' lounge!

1920.10 Double cone with ramp

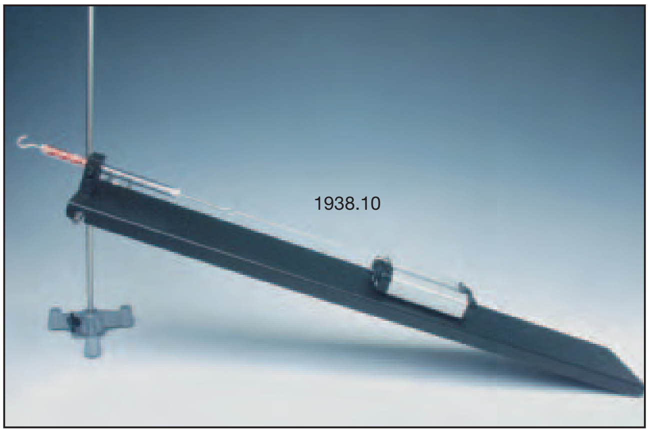
Air cushion disc with balloon

For demonstrating the influence of frictional forces. The disc consists of a circular plastic plate with an air hole and with a fitting for a rubber stopper with a hole for mounting a balloon. Air from the balloon passes through the hole in the plate, causing the disc to hover on a cushion of air. Acrylic plate diameter 115 mm.

1945.00 Air cushion disc with balloon

Balloons in package

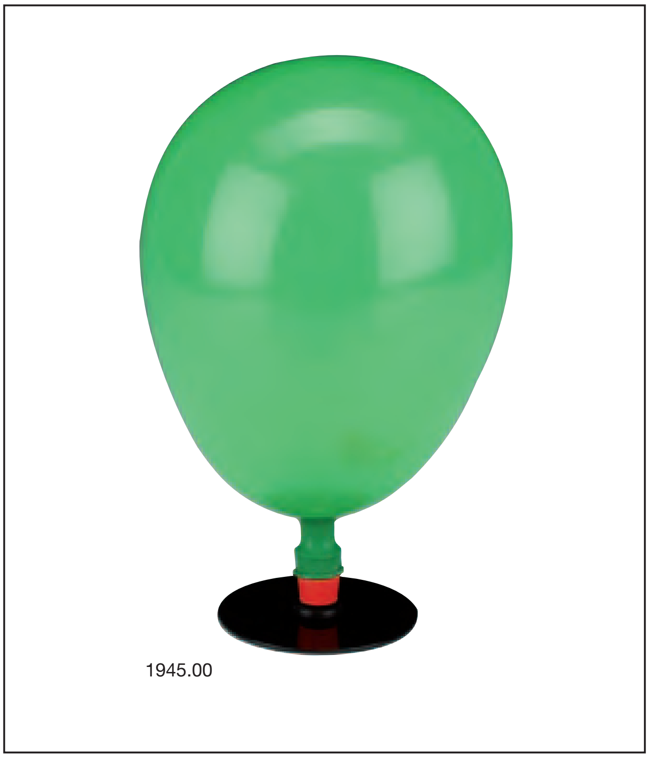
1945.10 Round balloons, 100 ea.

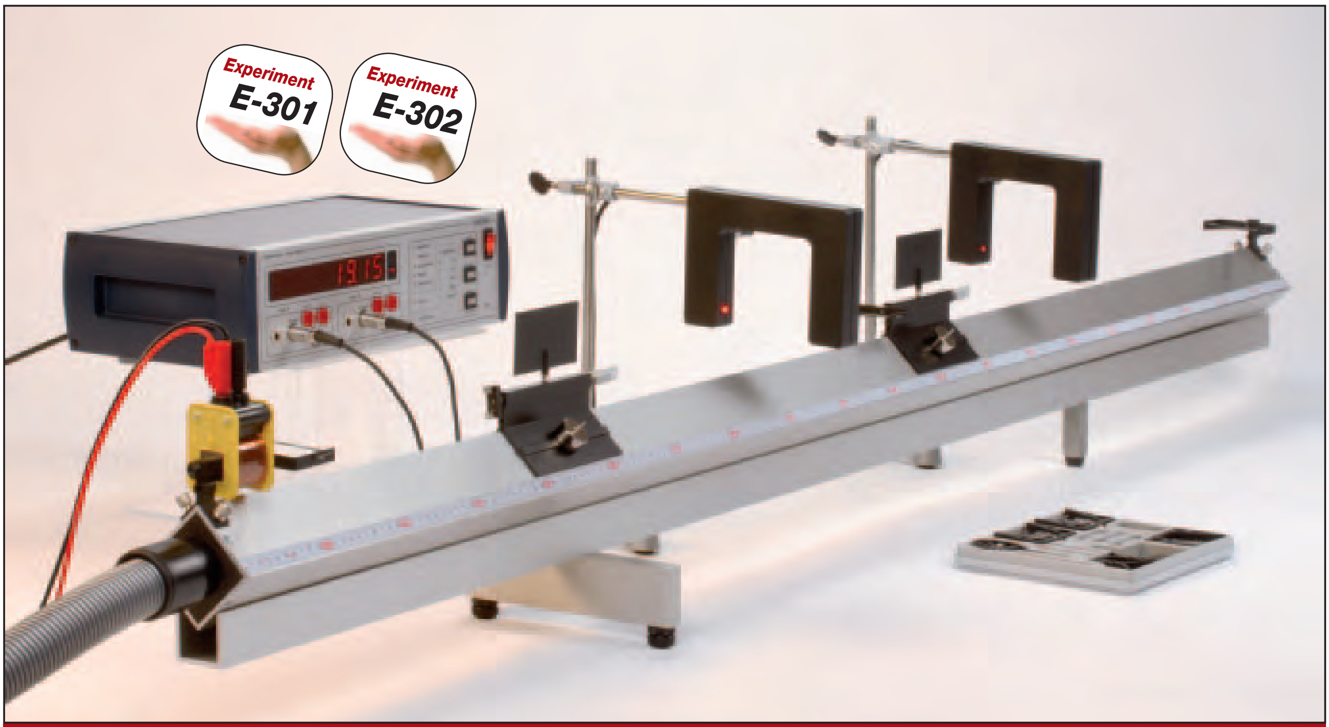


Inclined plane

Inclined plane and friction board 1000 mm x 150 mm
Inclined plane made of aluminium.
With holder for dynamometer.

1938.10 Inclined plane and friction board





Linear Air Track

No other systems have the same high quality for study of linear dynamics.

Because of extreme low friction the results will be up to 25% better compared to similar systems based on trolleys where higher friction and inertia of wheels occur.

Air track

For checking smooth uniform motion smoothly accelerated motion, Newtons Second Law, elastic and inelastic collisions.
The air track is made from a large square aluminium extrusion in conjunction with a supporting "U" channel. A series of 7 screws allow adjustment of the air track to a typical linearity of ±0.03 mm. The air track rests on three rubber feet, two of which can be height-adjusted.
The overall length of 2 meters provides a working length of 1.9 meters. The buffer at the end of the track as well as the carts are supplied with 4 mm. diameter holes for fixing plug-in units. All units have approximately the same center of gravity and the same mass of 10 g.
For accurate length measurements each side of the track has a scale graduated in mm.
A repeatable launch is desirable in many collision experiments. The electric launcher permit's launching of air track carts with repeatable impulses, varying the impulses as needed, and even launching two carts simultaneously.

Air track

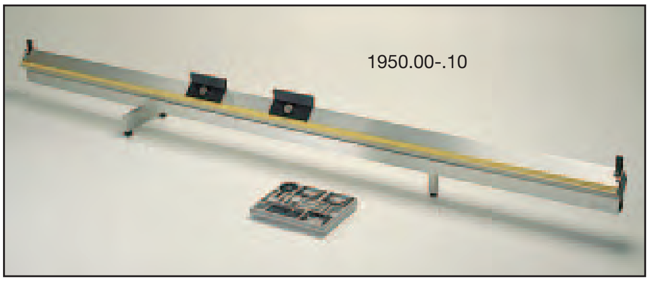
Standard version. The complete air track consists of the following parts: Air track 2000 mm, standard accessories in a plastic box, and two carts.

1950.00 Air Track

Air track

As no. 1950.00 but supplied with a "C" channel on the side for fixing the photocell unit no. 1975.10.

1950.10 Air Track



Standard air track accessory set

Supplied in a box with a lid and fitted partitions for the various parts. The set contains the following items:

Fork

For use along with 1955.10 for elastic collisions in conjunction with the firing mechanism no. 1952.00. Mass: 10 g.

1955.00 Fork with plug connectors, 3 ea.

Holder with plate

For elastic collisions with 1955.00. Mass: 10 g.

1955.10 Holder with plate and plug connectors, 3 ea.

Holder with needle

For inelastic collisions with 1955.30. Mass: 10 g.

1955.20 Holder with needle and plug connectors, 1 ea.

Tube with wax

For inelastic collisions with 1955.20.

1955.30 Tube with wax and plug connectors, 1 ea.

Holder with hook

Used as pulling hook for acceleration experiments. Mass: 10 g.

1955.40 Holder with hook and plug connectors, 1 ea.

Aperture 25 mm

Used as aperture for the photocell unit for time measurements. Mass: 5 g.

1955.60 Aperture with plug connectors, 25 mm, 2 ea.

Aperture 100 mm

Used as aperture for photocell unit for time measurements. Mass: 10 g.

1955.50 Aperture with plug connectors, 100 mm, 1 ea.

Cart for air track

Made of black lacquered aluminum. Supplied with mounting holes for accessories. Length: 125 mm. Mass: 170 g.

1960.00 Cart for air track, 2 ea.

Weight for cart

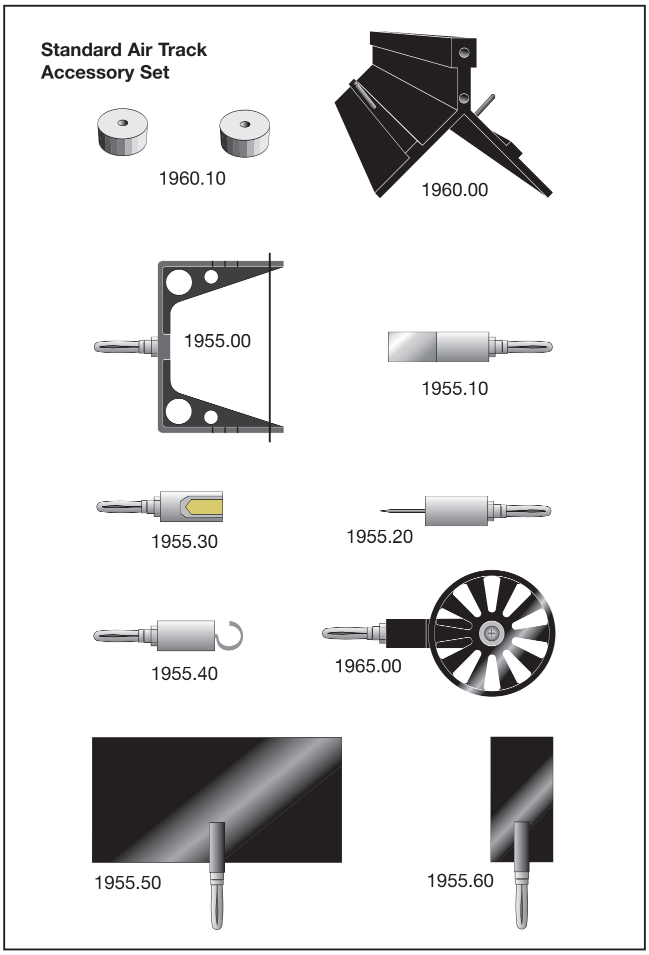
Additional weights for air track cart no. 1960.00. Mass: 50 g.

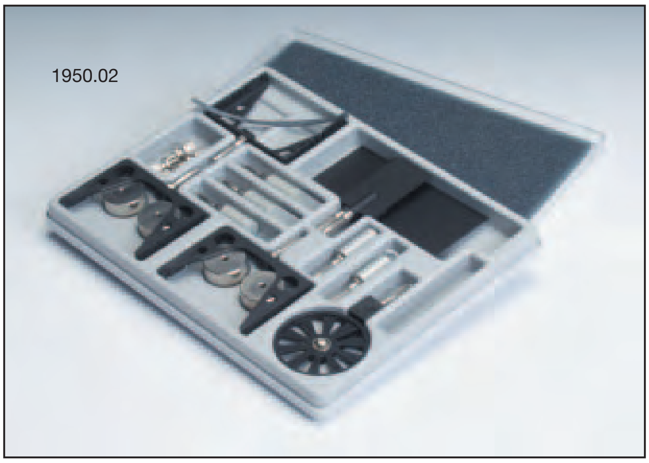
1960.10 Weight for air track, 4 ea.

Pulley

Low friction ball bearing pulley. Used for acceleration experiments. Mass: 13 g.

1965.00 Pulley with plug connectors, 1 ea.





Standard air track accessory set

As decribed above and supplied in a plastic box with lid. Cards for Air Track not included.

1950.02 Standard air track accessory set

Extra accessories:

Aperture with notch

Supplied with a notch for actuating start/stop of the electronic counter type 2001.00 and previous versions by means of photocell units. Starts and stops the counter on the high to low transition. Measurement length: 25 mm.

1955.70 Aperture with notch

Aperture with notch for side mounting

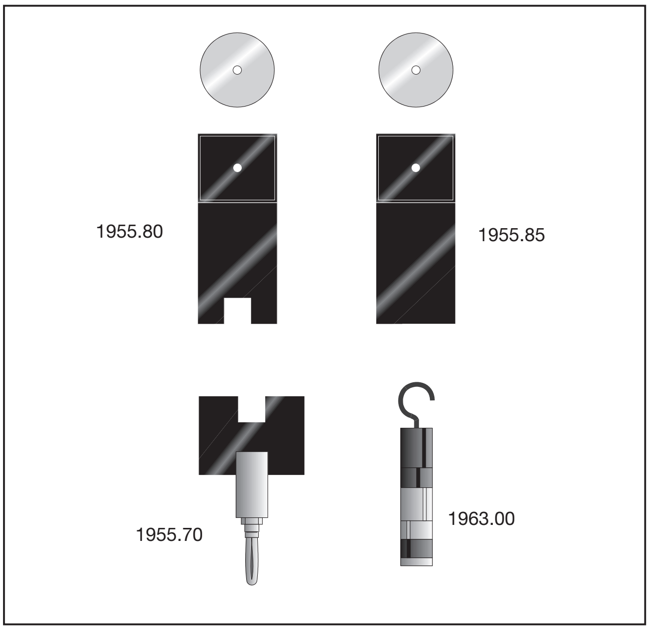
Aperture for side mounting on air track cart no. 1960.00. Supplied with a compensation weight to be placed on the opposite side of the cart. Supplied with a notch for start/stop of electronic counter type 2001.00 and earlier models by means of photocell units. Total mass: 10 g. Measurement length 20 mm.

1955.80 Aperture with notch for side mounting

Aperture for side mounting

Aperture for mounting on the side of the cart no. 1960.00. Supplied with a compensation weight to be positioned on the opposite side of the air track cart. Total mass: 10 g. Width: 30 mm.

1955.85 Aperture for side mounting



Slot weights with holder

Used for accelerating the air track cart. The set consists of a 2 g holder, 2 ea. 1 g weights, 1 ea. 2 g weight, 1 ea. 5 g weight, 1 ea. 10 g weight. Total mass: 21 g. This set permits combinations of masses from 2 g to 21 g.

1963.00 Slot weights with holder

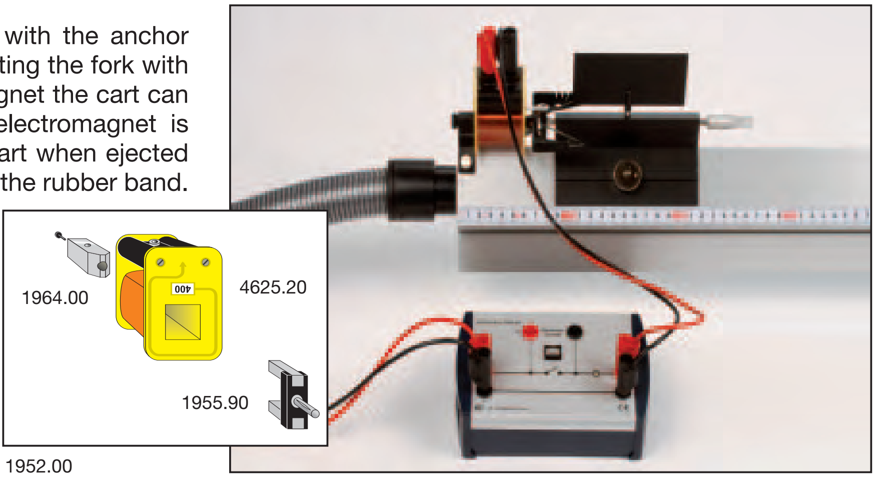
Electric launcher

The set consists of an electromagnet with the anchor mounted on the air track cart. By mounting the fork with rubber band (1955.00) in the electromagnet the cart can be ejected when the current to the electromagnet is switched off. The force acting on the cart when ejected can be varied by varying the tension on the rubber band. There is good repeatability.

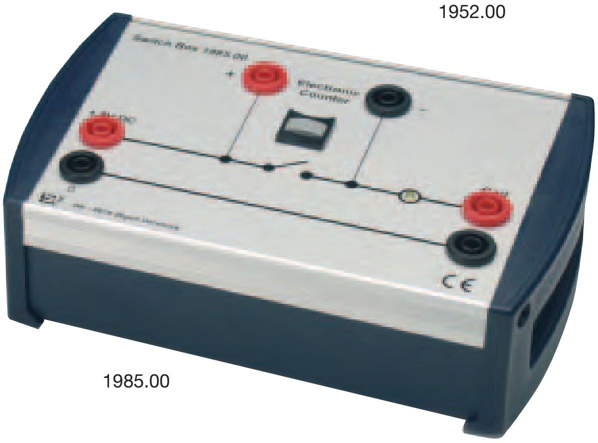
The set consists of:

Iron core 20 x 20 x 51 mm with mounting screw (1964.00).
Coil with 400 windings (4625.20)
Anchor with plug connector (1955.90)

1952.00 Electric launcher



1952.00



1985.00

Switch box

The box is used to interrupt the current to the firing mechanism used on the air track. Supplied with a capacitor and output jack connections to counter no. 2002.50.

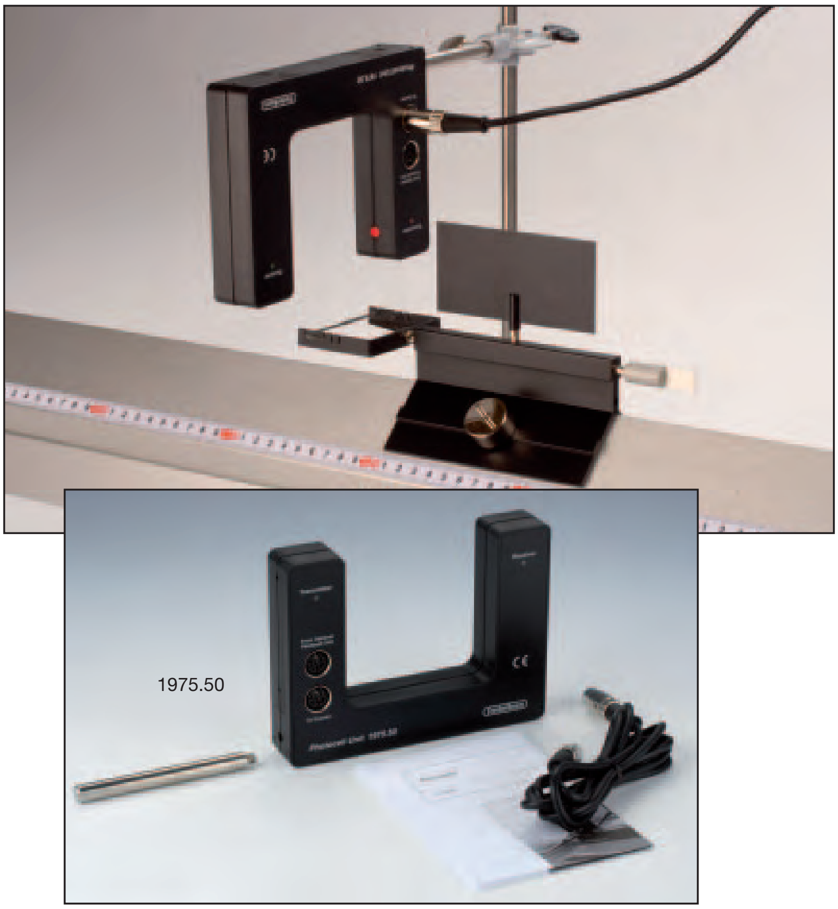
1985.00 Switch box

Photocell unit

This item is for measuring pendulum swings, time measurements on the air track, measurements of rotation rates, etc. The unit consists of a photocell which receives light transmitted from a light emitting diode (LED) through a 1 mm aperture. Next to the light source LED and next to the photocell red and green LED's are mounted to indicate whether a signal is reaching the photocell from the light source and whether the light source is on. The photocell unit is provided with two 6-pole DIN-connectors for connection to electronic counter type 2002.50 and extension to additional photocell units if additional signals are to be connected to the same input on the counter. They are made of impact-resistant plastic and provided with threads for vertical or horizontal mounting with the 10 mm diameter mounting rod (also supplied). Supplied with a connection cable to the electronic counter. Maximum distance between the photocell and the LED: 90 mm.

Width: 160 mm, height: 120 mm, thickness: 28 mm. Mass: 450 g.

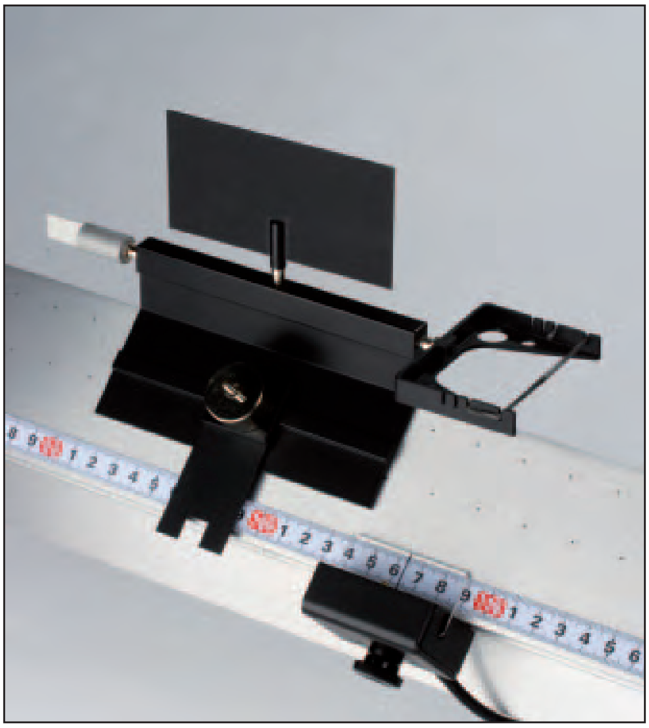
1975.50 Photocell unit incl. cable and mounting rod


1975.50

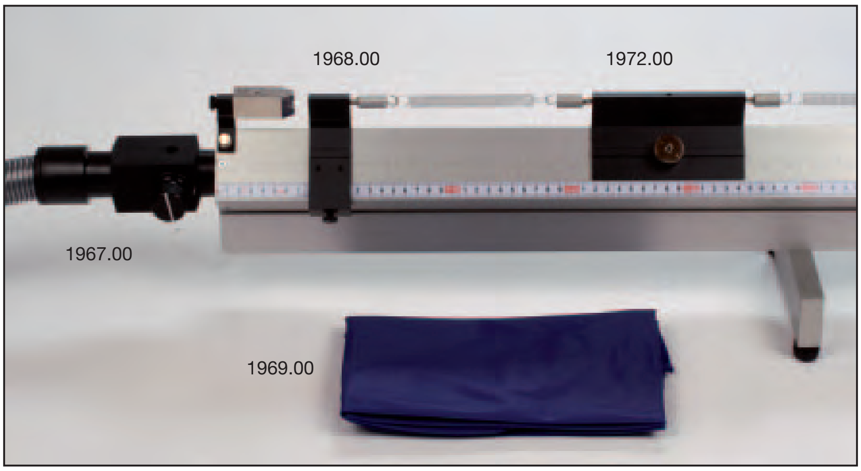
Photocell unit

Used for timing on the air track. The unit is made especially for mounting on air track no. 1950.10. Provided with slide indicator and plugs for 2002.50.

1975.15 Photocell unit



1975.15



Air switch

To be placed between air hose and air track in order to switch off the air supply.

1967.00 Air switch

Adjustable endstop

Made of anodized aluminium with 4 mm. diameter hole for plug-in units.

1968.00 Adjustable endstop

Protective cover for air track

Protective cover, made of soft plastic with rim of lead.

1969.00 Protective cover

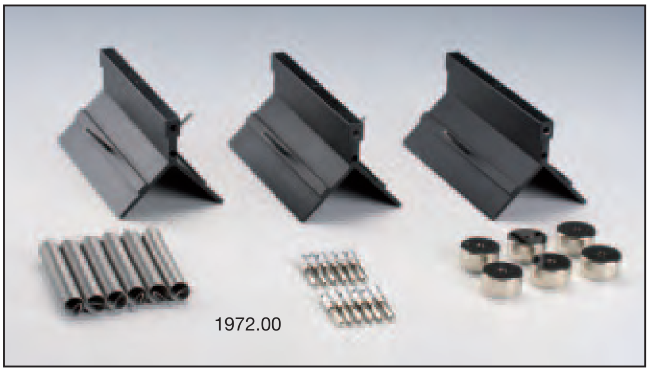
Coupled harmonic oscillators

You can link up to five Air Track Carts together for the study of harmonic of coupled harmonic motion, or you can use a single cart with one or more springs for a detailed, quantitive study of simple harmonic motion. Additional you can use Electromechanical Vibrator no. 2185.00 and drive the coupled oscillators at fixed and measurable frequencies.

The set consist of the following parts:

1969.00 Cart for Air Track 3 ea.
(2 ea. Supplied with the Air Track)
1960.10 Weight for Cart 6 ea.
2155.20 Spring Connectors 6 ea.

1972.00 Coupled Harmonic Oscillators



Air blower

Extremely quiet air blower with continuously adjustable speed. The air blower is designed especially for operation of the air tracks no. 1950.00 and 1950.10. Complete with 1.7 m hose. Mains supply: 220-240 V AC. Dimensions: 280 x 250 x 210 mm. Mass 5.7 kg.

1970.50 Air blower

Electronic counter

A digital time counter which can be started and stopped using photocells, electronic switches and pulses. Well-suited for use for time measurements on the air track, measuring the time in free-fall experiments, elapsed time when objects are thrown, etc. It can also be used for frequency measurement and pulse counting. See additional specifications on page 17.

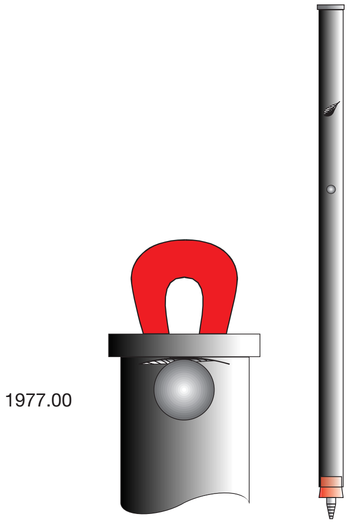
2002.50 Electronic counter

2002.50

Free-fall tube

For demonstrating that the free fall acceleration in a vacuum is independent of weight and shape of body. Consists of a acrylic plastic tube 30 x 900 mm. End-cover, stop-cock, magnet, steelball and paper disc.

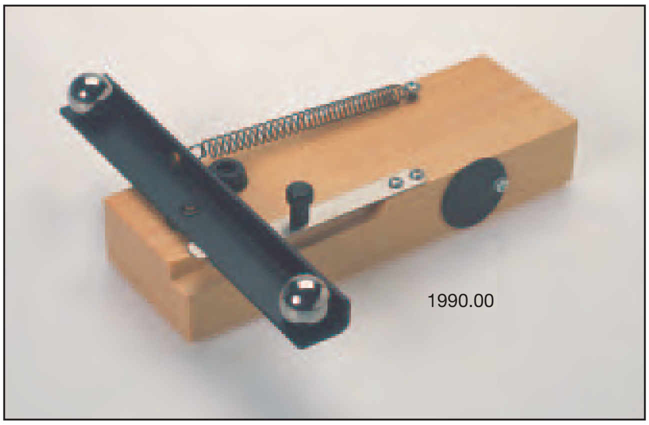
1977.00 Free-fall tube

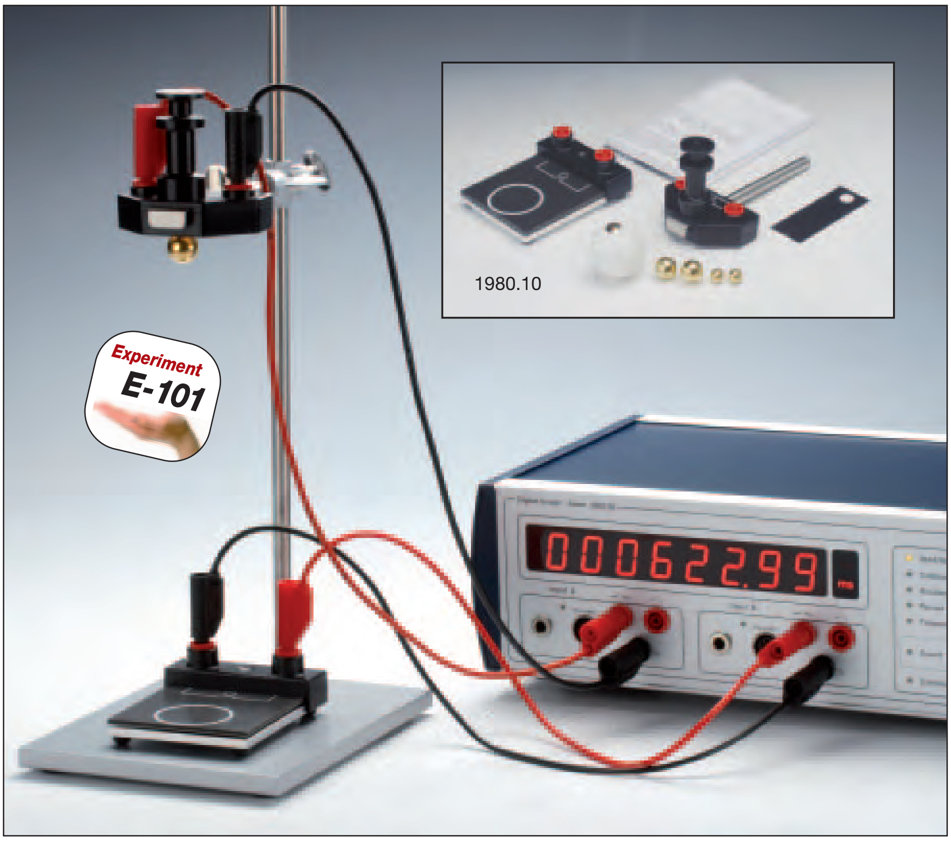


Falling bodies apparatus

To illustrate that a body impelled horizontally will fall vertically at the same rate as a similar body allowed to fall freely. Place two balls one on each end of the swing arm and push the release. One ball is dropped and the other is launched horizontally, the simultaneous “click” as both balls hit the floor at the same time proves the point. Supplied with 2 19 mm dia. balls in the storage pocket. Dimensions: L 180 mm, W 170 mm, H 50 mm.

1990.00 Falling bodies apparatus

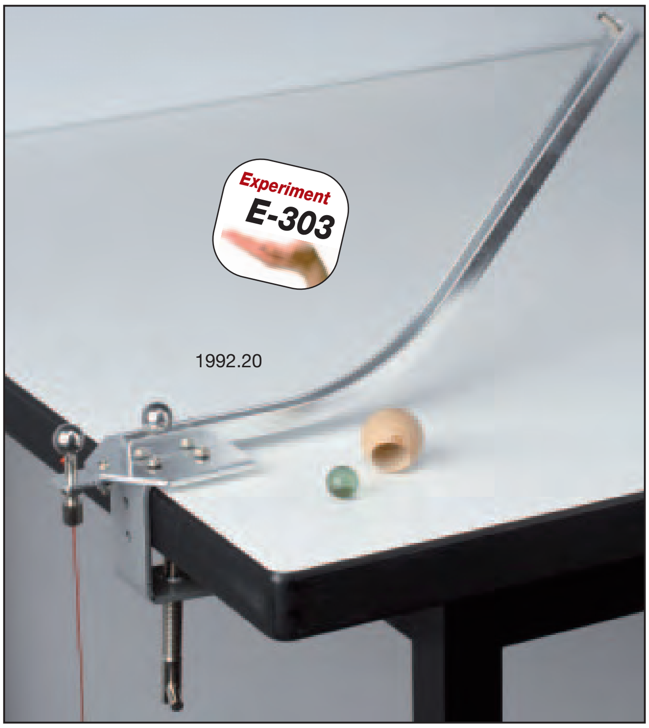




Free fall apparatus

This apparatus is designed to be used with an Electronic Counter to determine the fall time for a freely falling steel ball. The apparatus consists of a release mechanism which also acts as the start switch, a strike plate which acts as the stop switch and gold-plated steel balls. The release mechanism is provided with two dia. 4 mm banana plug connectors for connecting safety dia. 4 mm banana plug leads to the Counter start switch input. A 10 mm diameter mounting rod for supporting the mechanism on a lab stand is supplied. The strike plate is also provided with two dia. 4 mm banana plug connectors for attaching this unit to the Counter stop input.

1980.10 Free fall apparatus



Curved ball track

Used for two dimensional collision experiments. A simple but dependable apparatus for demonstrating elastic and inelastic collisions in two dimensions. Because the fall time to the floor is independent of any initial horizontal velocity, the horizontal displacement can be converted to a relative velocity, permitting the momentum to be computed. In order to obtain the full benefit from this experiment, students should be familiar with vectors. The set consists of a curved ball track with mounting hardware, two 12 mm steel balls, one 12 mm glass ball and a hollow 25 mm wooden ball. A weight and plumb line are also supplied.

1992.20 Curved ball track

REQUIRED ACCESSORIES:

1992.10 Easily smudged carbon paper

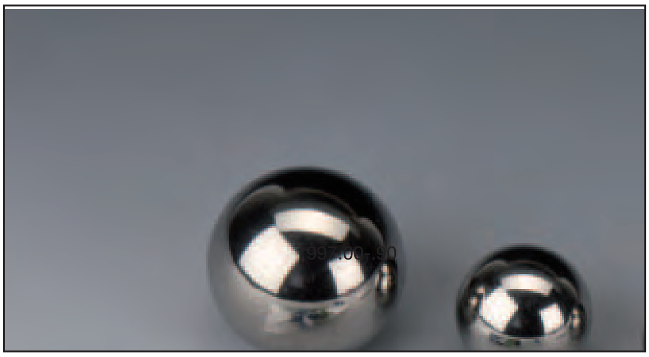
Steel balls

These balls are used for experiments involving motion and energy.

1997.10 Diameter 40 mm
1997.20 Diameter 28 mm
1997.30 Diameter 25 mm
1997.40 Diameter 20 mm
1997.50 Diameter 18 mm
1997.60 Diameter 16 mm
1997.70 Diameter 12 mm
1997.80 Diameter 10 mm
1997.85 Diameter 6 mm
1997.90 Diameter 3,2 mm, 200 pcs.

Glass balls

1999.00 Diameter 16 mm



Ticker tape timer

For measuring elapsed time of linear motion. The timer comprises an AC coil acting on a spring suspended marker plate that in conjunction with a spring loaded ball (adjustable from the bottom plate) makes dots on a 17.5 mm wide paper tape with the time interval 0.02 sec. 64 mm dia. carbon disc can be used for marking. The ticker tape timer is made of nickel-plated steel. The top plate with the AC coil is hinged to the steel body and locked by means of a magnet.

2005.00 Ticker tape timer

Carbon paper discs

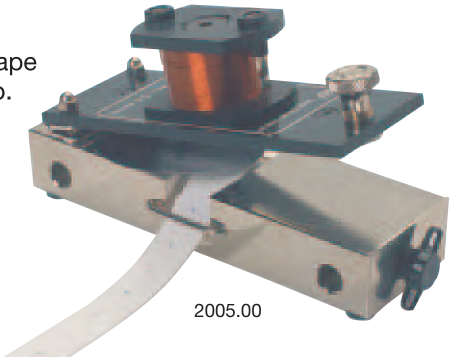
For the ticker tape timers no. 2005.00. Package of 50 ea. Diameter 64 mm.

2005.30 Carbon paper discs

Tape

17.5 mm wide tape for the timers no. 2005.00, 360 g roll.

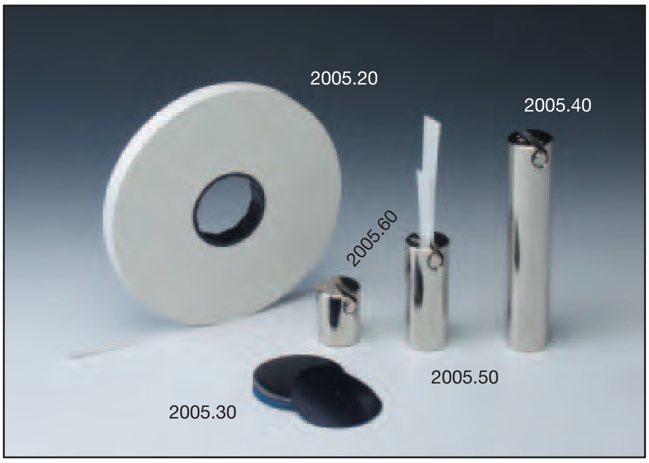
2005.20 Tape

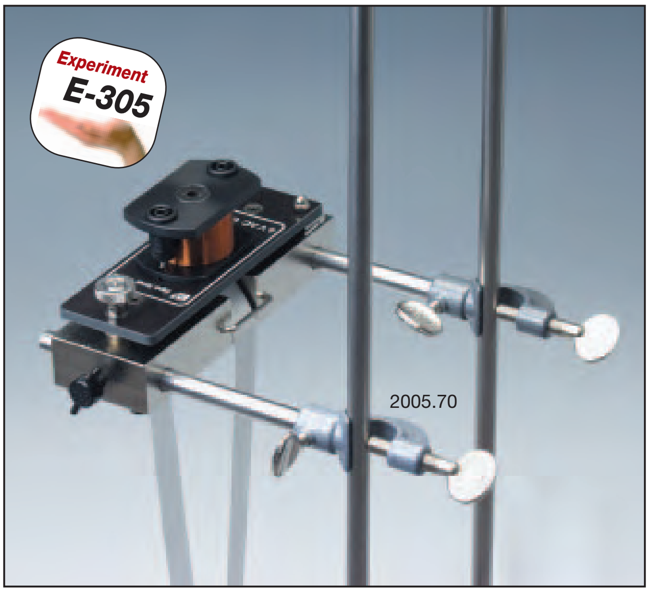


Drop weight

Nickel-plated iron weight with self tightening locking mechanism for the tape, for use with the ticker tape timer no. 2005.00. Diameter: 32 mm. Height: 160 mm.

2005.40 Drop weight 1 kg, height 160 mm
2005.50 Drop weight 0,5 kg, height 82 mm
2005.60 Drop weight 0,25 kg, height 42 mm





Rod with mounting bracket

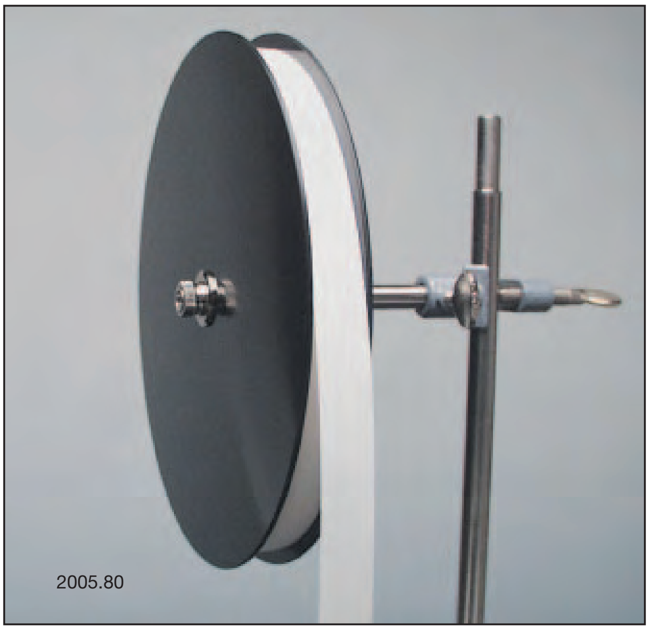
Appropriate for mounting of timer 2005.00 as shown in the figure. The bracket has a stoved enamel finish and the rust free steel rod has a 10 mm diameter. Total length: 230 mm.

2005.70 Rod with mounting bracket

Timer tape holder

The holder is for timer tape (2005.20). It is made of black plastic with ball bearings and a 10 mm diameter mounting rod and bracket of rust free steel.

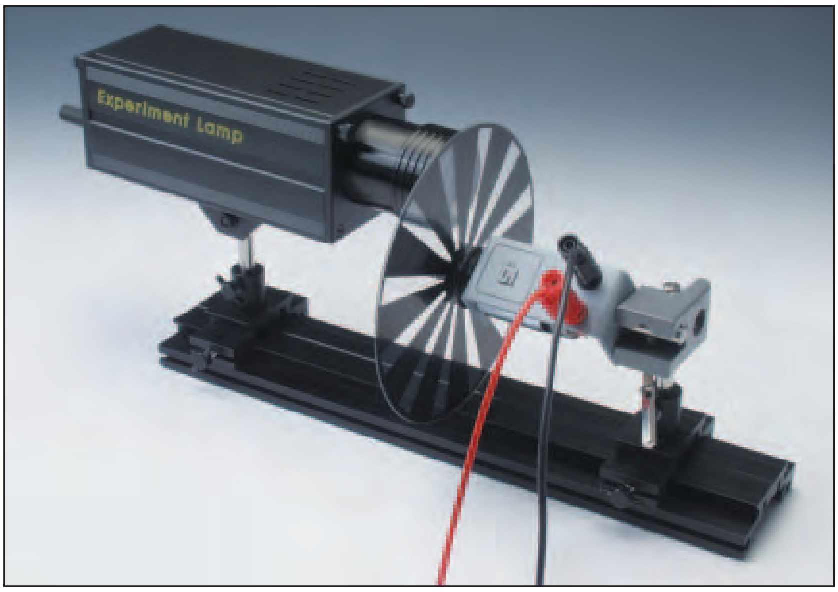
2005.80 Timer tape holder



Stroboscope disc

Made af black-lacquered plastic with 1 aperture.
For use with e.g. motor no. 2025.00 and illuminator.
Diameter 170 mm, hole diameter 8 mm.

2020.00 Stroboscope disc

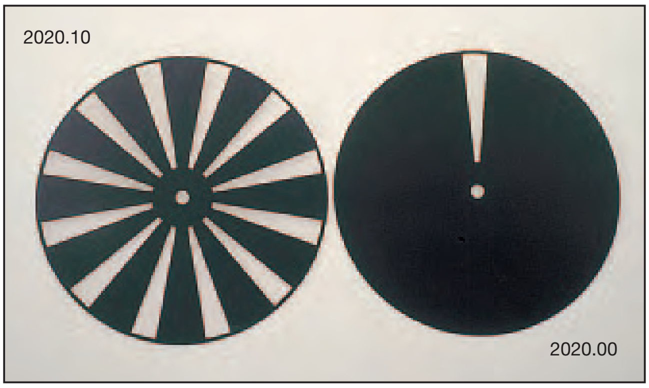


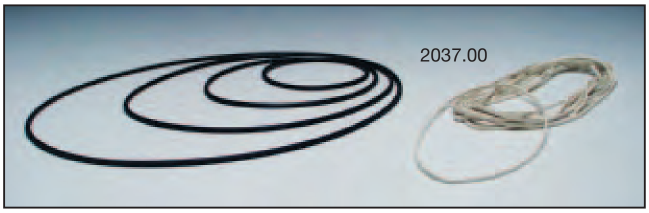
Stroboscope made of experiment lamp and stroboscope disc.

Stroboscope disc

As 2020.00 but with 12 apertures.

2020.10 Stroboscope disc

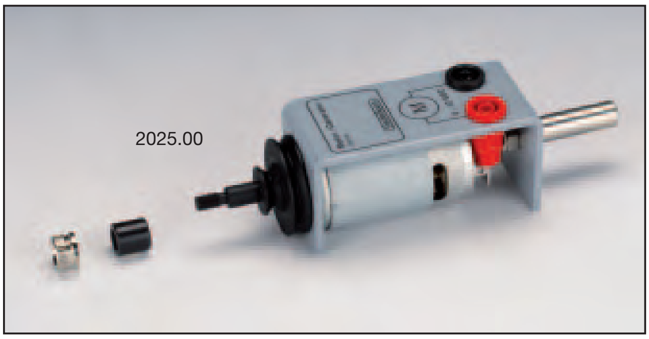




Motor with winding shaft

This universal motor is for operating units such as strobe discs, color discs, apparatus and models. Furthermore, the motor can be used as a generator in energy experiments, etc. The unit is provided with a sturdy DC motor with a permanent magnet stator.
A 2 step drive belt shaft is supplied along with a cylindrical winding axle with diameters of 8 and 12 mm. Supplied with a 35 mm 10 mm diameter mounting rod. Total length: 225 mm. Width: 40 mm. Height: 40 mm. Operating voltage range 0-12 V DC 0-4800 rpm, mass 0.35 kg.

2025.00 Motor with winding shaft



Drive belt set

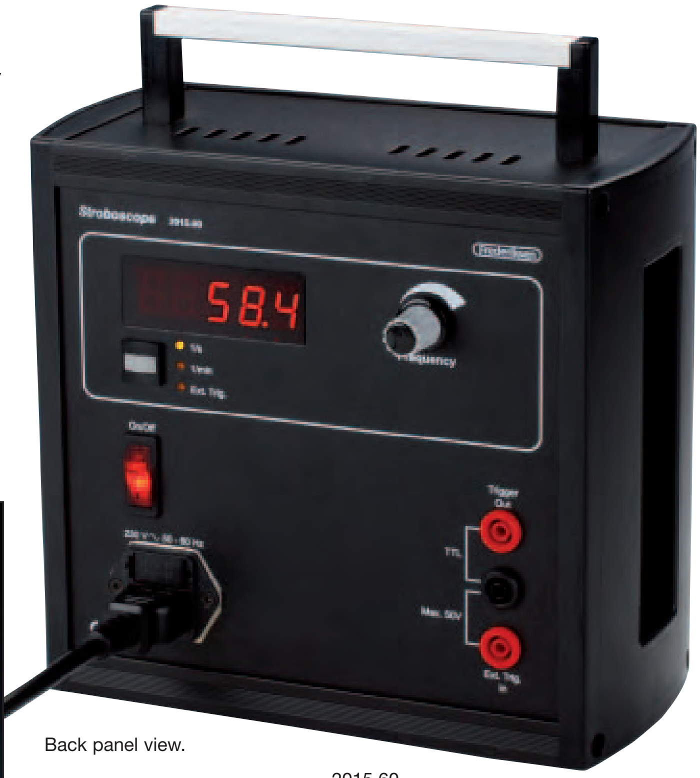
Four different flexible, black synthetic rubber drive belts are supplied. Belt lengths: 240, 289 and 780 mm. The drive belts are oil resistant.

2037.00 Drive belt set, 4 different belts

Stroboscope

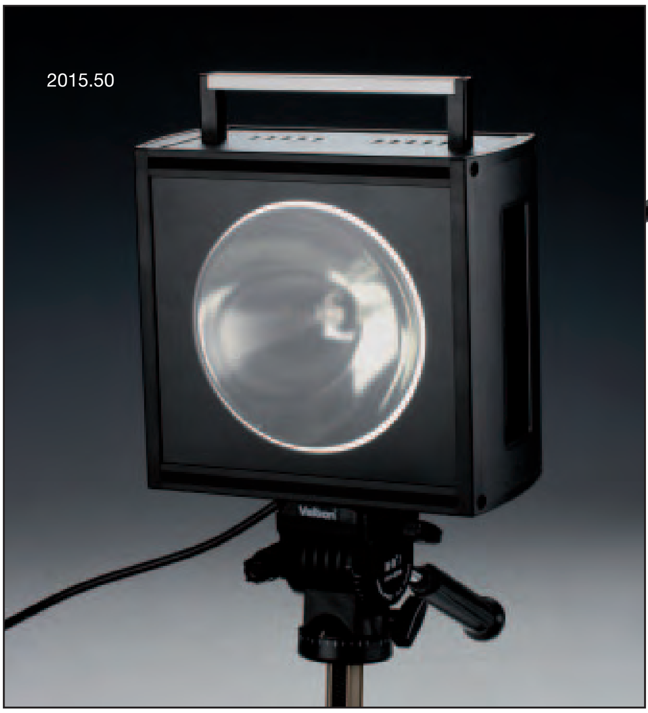
A portable instrument employing a high intensity xenon flash tube which gives a brilliant white light, particularly suitable for photographic purposes.
The flash rate can be regulated from 1.0 to 300.0 flashes per second or 1 to 18 000 rpm. Digital reading with switch for impulses per second, rpm. and external trigging. Input terminals for external trigging and output terminals for internal triggering.
Mains power supply: 220 V AC/50-60 Hz. Equipped with threaded hole for stand in base.
Dimensions:
180 x 240 x 120 mm, W x H x D.

2015.60 Stroboscope



Back panel view.

2015.60



Front panel view.

Photo/video tripod

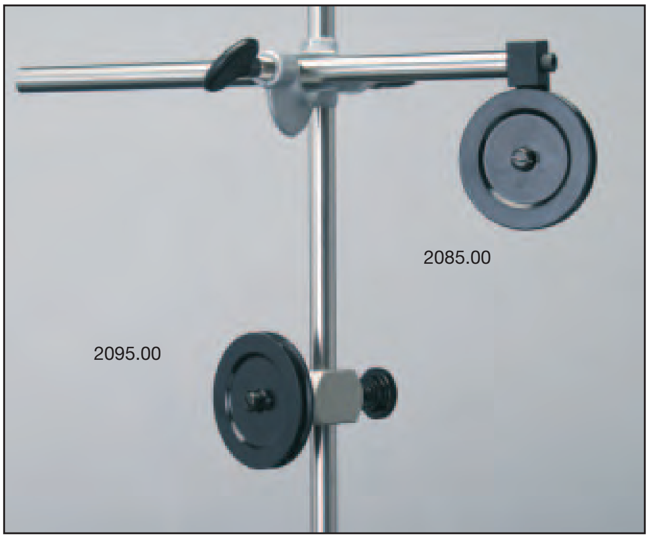
This tripod is ideal for use with the Stroboscope no. 2015.50. Made of black eloxated aluminium. Adjustable to any desired height - max. 1450 mm. The quick camera mount fits into the stroboscope's standard thread. Extremely handy, takes up practically no space when folded away yet very stable in use. Net mass: 1.750 kg.

2030.16 Photo/video tripod

Circular motion apparatus

For experiments with uniform circular motion this setup is simple and easy to use. Using a small motor a weight is caused to move in a circle. The mass of the weight, the rotational speed and the angle the string makes with the vertical allow the confirmation of the equations of circular motion. The set consists of a small DC motor at the end of a support rod with connection leads, three different rubber balls and strings with snap locks. Supplied with laboratory exercise instructions.

2070.00 Circular motion apparatus



Pulley on steel rod

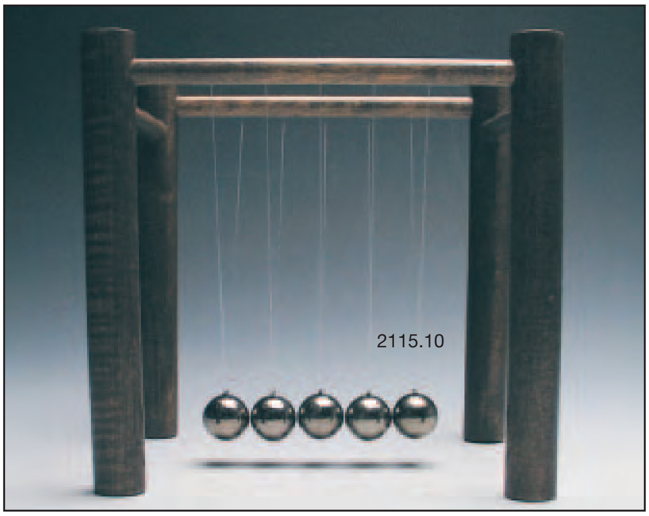
Low friction pulley made of plastic 47 mm dia. Mounted on a 10 mm dia. fixing rod, length of rod 200 mm. Mass: 0.14 kg.

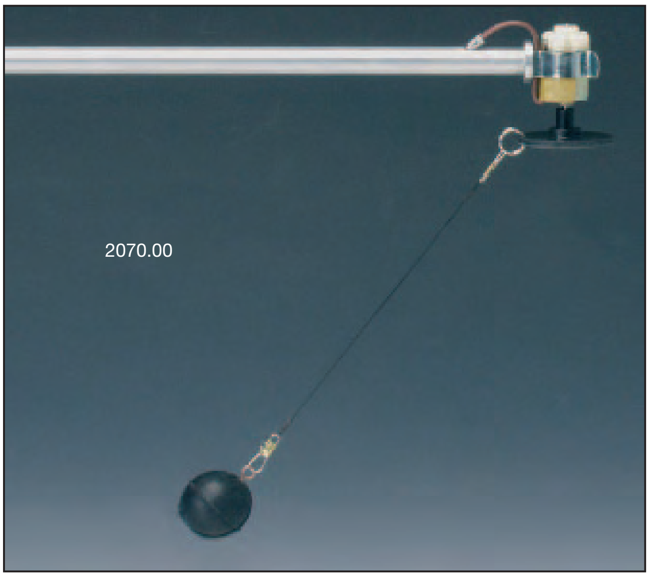
2085.00 Pulley on steel rod

Pulley with clamp

Pulley made of plastic 47 mm dia. Supplied with clamp for clamping on e.g. a retort stand rod.

2095.00 Pulley with clamp





Pulley block in line

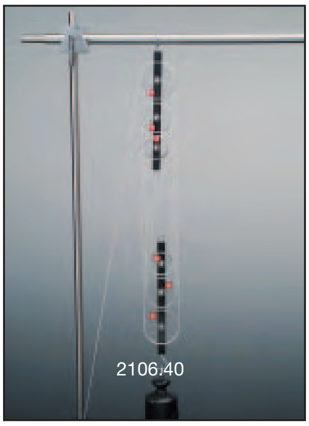
Pulley block comprising 2 pulley blocks in line for the demonstration of the principle of a pulley block. Each block consists of 3 pulleys in line. Pulleys dia. 34 mm, 40 mm and 47 mm. Length: 175 mm. Mass: 0.27 kg per set.

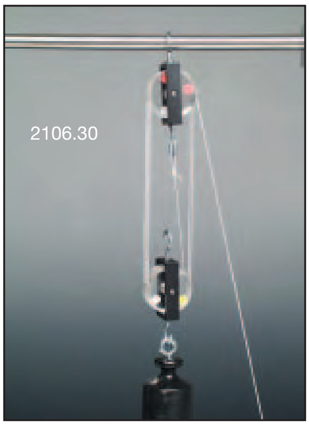
2106.40 Pulley block in line

Pulley block

Set consists of 2 blocks with 3 pulleys for making a demonstration model of a pulley block. Pulleys 40 mm dia. Mass: 0.3 kg per set.

2106.30 Pulley block





Collision apparatus

This apparatus is designed to illustrate Newton's third law of motion: action and reaction forces act upon different bodies and are oppositely directed. The apparatus is also suitable for the demonstration of momentum conservation. The collision apparatus is supplied with 5 ea. 25,4 mm diameter nickel coated steel balls suspended by double strings in a robust wooden frame. Size: length: 227 mm, width: 183 mm, height: 222 mm. Mass: 0.7 kg.

2515.10 Collision apparatus

Prandtl's rotating disc

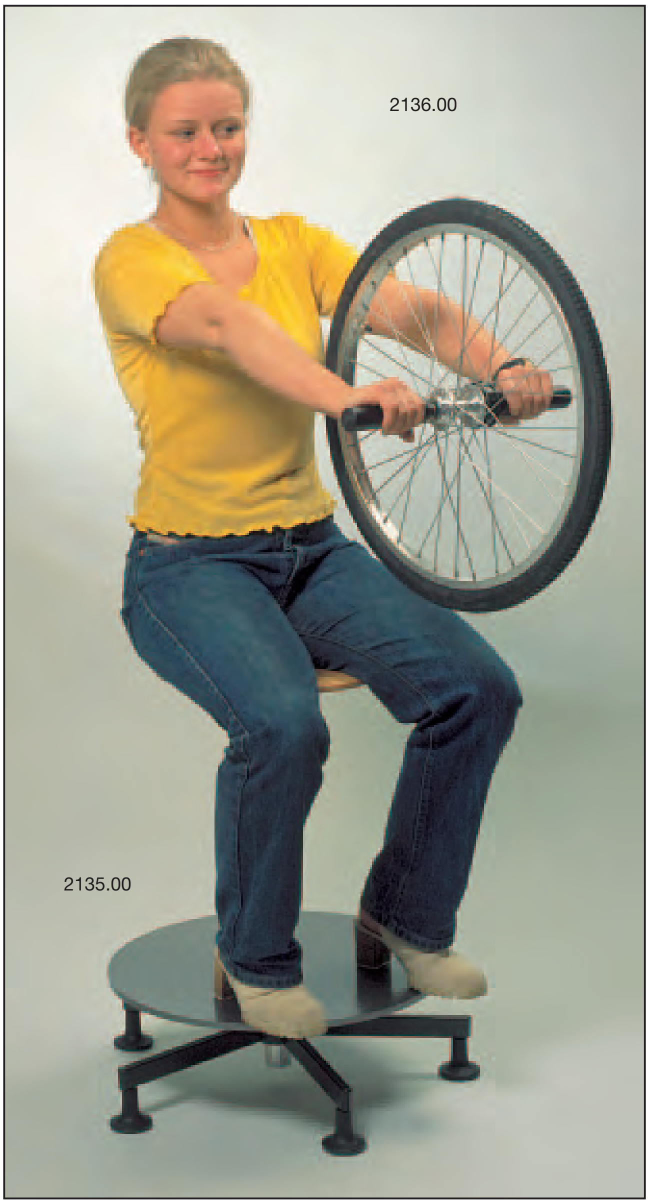
For demonstrating the principle of the conservation of angular momentum. A 480 mm diameter metal disc with ball-bearing axle on base with levelling screws and supporting stool.
Dimensions: Height 150 mm. Weight: 9.5 kg.

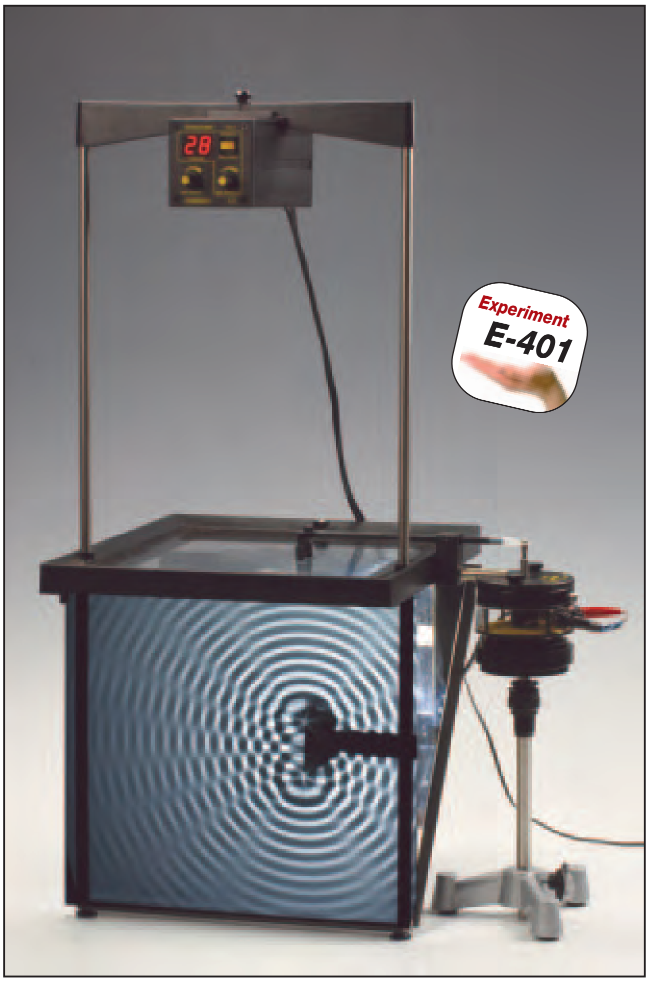
2135.00 Prandtl's rotating disc

Bicycle wheel gyro

Suitable for demonstrating the conservation of angular momentum with a rotating stool or disc. A 500 mm diameter spoked wheel with plastic lined rim, axle and 2 handles. Supplied with pulley and 1.5 m nylon cord.

2136.00 Bicycle wheel gyro





Ripple tank

Whether you are dealing with the wave properties of light, electromagnetic waves, sound or other types of waves, their behavior is analogous to the behavior of waves on a water surface.

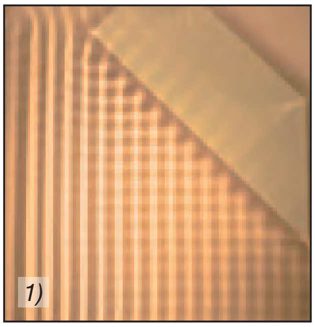
In a teaching situation water waves have the advantage of being visible and moving so slowly that students can observe wave phenomena directly.

By taking advantage of the optical properties of water waves, phenomena, can be enlarged and made visible on a screen.

The Ripple tank provides a dramatic demonstration of the general properties of waves and propagation phenomena.

1) *Reflection and refraction. By using the linear dipper bar plane parallel waves can be produced. The waves exhibit reflection and refraction when appropriate barriers are used in the water tank.*
2) *Inteference phenomena occur when two point source dippers generate circular waves. The distance between the sources and their frequency can be regulated.*
3) *Plane parallel waves form point wave sources when they encounter a double slit formed by three barriers.*
4) *The propagation velocity is dependent upon the depth of the water layer. The transparent lens cross section is covered by a shallow layer of water.*

2211.00 Ripple Tank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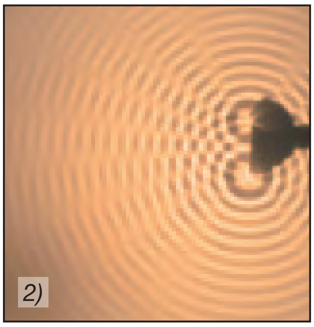
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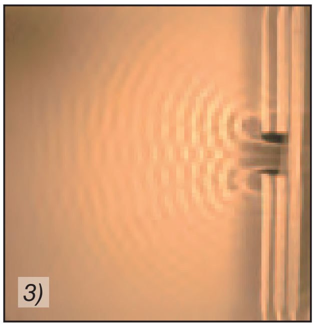
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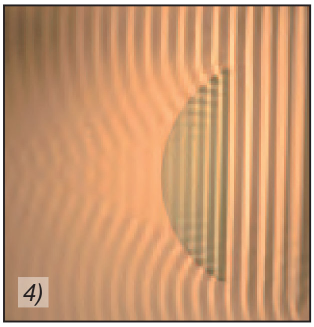
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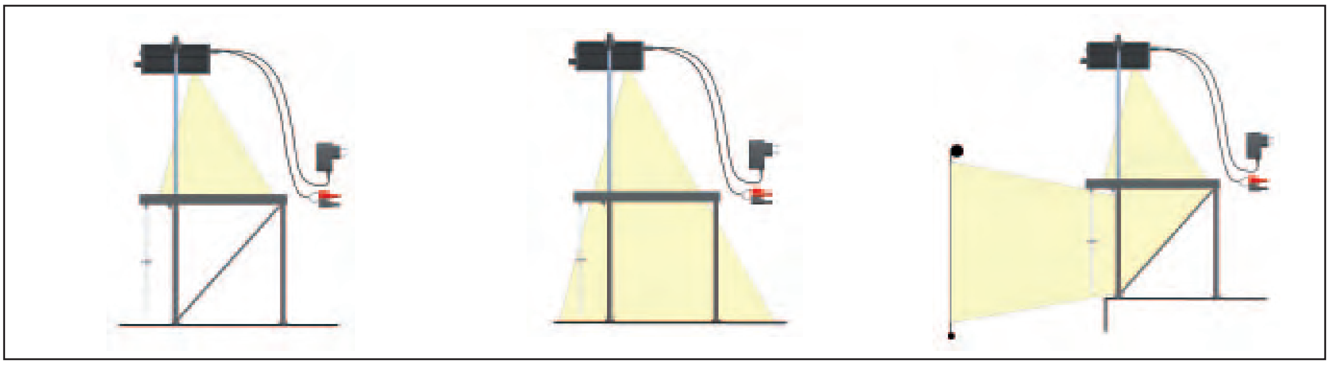
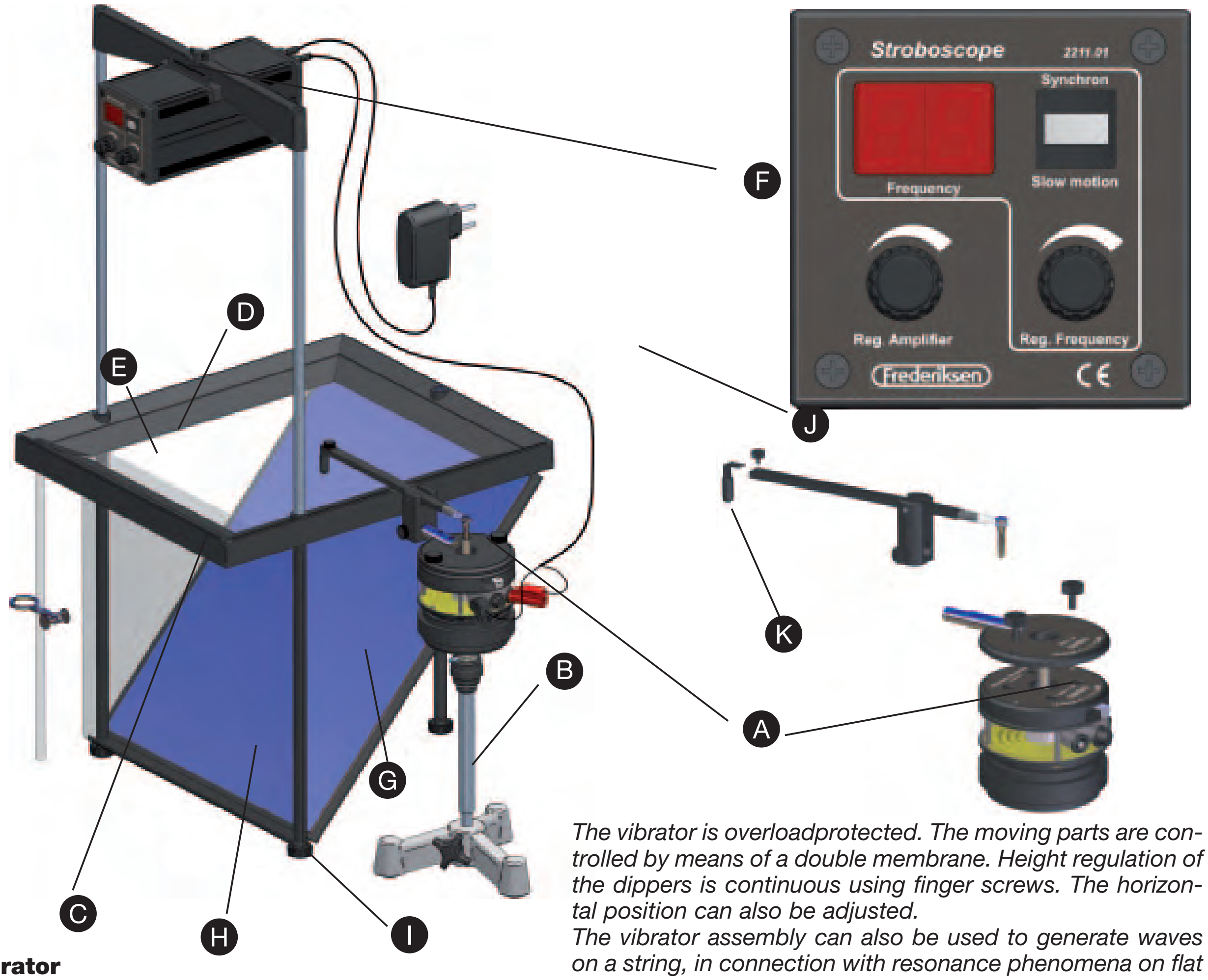


Projection

Intense illumination from the strobe light enables the images to be enlarged and projected using several techniques. On a table it is well-suited for group work e.g. in lab exercises. On a screen it is ideal for classroom demonstrations or lecture halls.



Ⓐ **Vibrator**
Wavegenerator in phase with strobelight.

Ⓑ **Support with height adjustment**
The generator assembly can be adjusted so that the dippers just touch the water.

Ⓒ **Ripple tank**
Manufactured of reinforced plastic.

Ⓓ **Wave dampers**
Impede the reflection of incident waves.

Ⓔ **Glass bottom surface**
Easy to clean and scratch resistant.

Ⓕ **Stroboscope**
The light source is a white LED (3W). The LED has a very long lifespan,espimated up to 100.000 hours, thus a change of light source will not be relevant.

Ⓖ **Projection mirror**
Scratch resistant and easy to clean with protective backing plate.

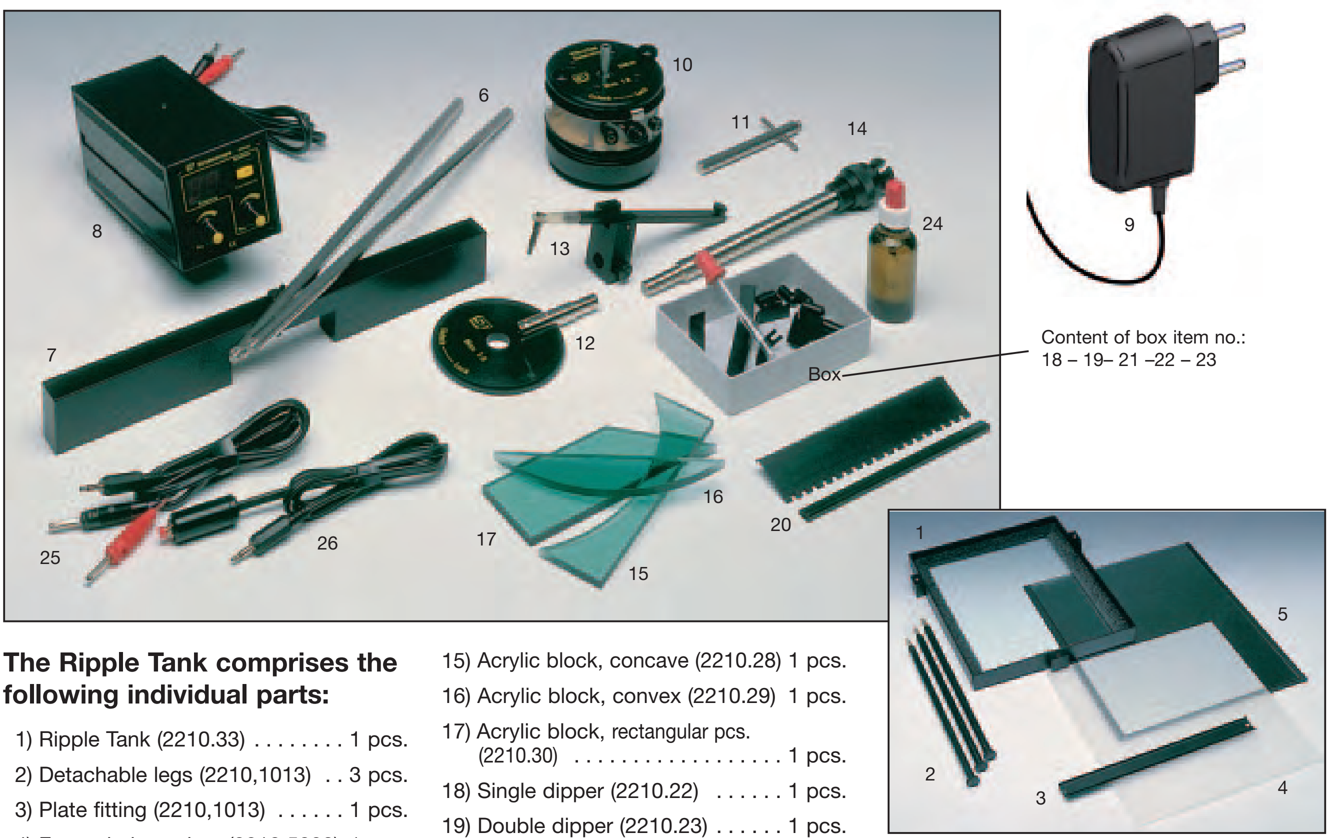
Ⓗ **Projection screen**
A specially produced projection screen ensures optimum sharpness.

Ⓘ **Footers with adjustment screws**
The Ripple tank is supported by three legs to ensure a stable setup and to permit exact regulation of water depth.

Ⓙ **Power supply**
The Ripple Tank is delivered with a mains adapter.

Ⓚ **Wave dippers**
The standard set includes various dippers and lens profiles.

The vibrator is overloadprotected. The moving parts are controlled by means of a double membrane. Height regulation of the dippers is continuous using finger screws. The horizontal position can also be adjusted.
The vibrator assembly can also be used to generate waves on a string, in connection with resonance phenomena on flat plates and for the demonstration of the states of matter.



Content of box item no.:
18 – 19– 21 –22 – 23

The Ripple Tank comprises the following individual parts:

1) Ripple Tank (2210.33)	1 pcs.
2) Detachable legs (2210,1013)	3 pcs.
3) Plate fitting (2210,1013)	1 pcs.
4) Frosted glass plate (2210,5093)	1 pcs.
5) Mirror (2210,1011)	1 pcs.
6) Fixing rods for Strobe-unit (2210.62)	2 pcs.
7) Traverse f. Strobe-unit (2210.62)	1 pcs.
8) Strobe-unit (2211.01)	1 pcs.
9) Power Supply (3550.50)	1 pcs.
10) Vibration Generator (2185.00)	1 pcs.
11) Mounting pin 2185.06)	1 pcs.
12) Holder for lever arm (2185.05)	1 pcs.
13) Lever Arm w. pivot (2210.32)	1 pcs.
14) Height adjust unit (2185.07)	1 pcs.
15) Acrylic block, concave (2210.28)	1 pcs.
16) Acrylic block, convex (2210.29)	1 pcs.
17) Acrylic block, rectangular pcs. (2210.30)	1 pcs.
18) Single dipper (2210.22)	1 pcs.
19) Double dipper (2210.23)	1 pcs.
20) Dipper for parallel waves w. plane wave attachment (2210.25)	1 pcs.
21) Single dipper (unmounted) (2210,2202)	5 pcs.
22) Barrier, long (2210.26)	2 pcs.
23) Barrier, short (2210.27)	1 pcs.
24) Pipette flask w. special solvent (2210.31)	1 pcs.
25) Connection cable for Vibration Generator (1100.75)	1 pcs.
26) Remote Control (1100.80)	1 pcs.

The ripple tank set is supplied complete in a fiber box segmented for storing the components and with complete user instructions.

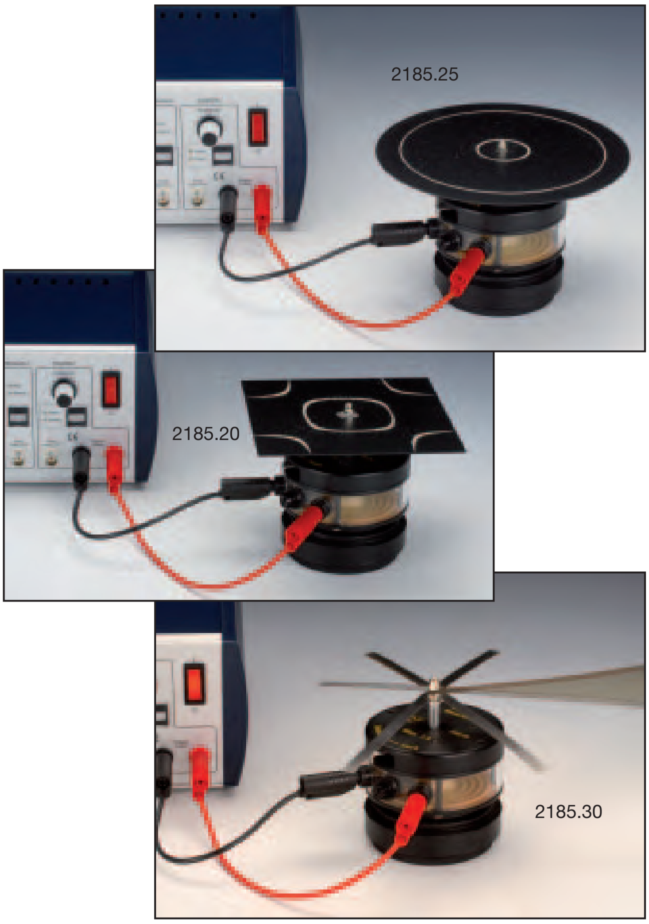
2210.50 Ripple Tank, Complete

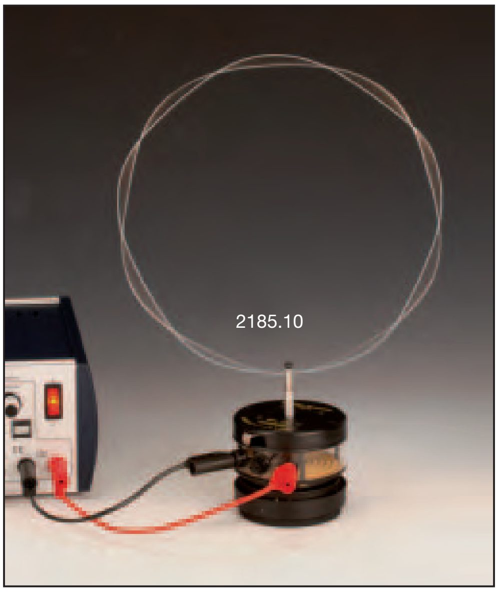
Electromechanical vibrator

The vibrator generates mechanical vibrations when used with a signal generator as e.g. catalog no. 2500.00 or 2501.50. The input signal is supplied to a coil which is mounted in a magnetic field from a cylindrical magnet. The unit is fuse-protected.
It is supplied with a lock which protects moving parts while changing accessories. It is supplied with mounting hardware, a string holder and extra fuses.
Max. input: 6 V/1A.
Dimensions: 100 mm diameter x 120 mm.
Mass: 1.26 kg

2185.00 Electromechanical Vibrator

Vibrator accessories:





Piano wire ring

For use with 2185.00 for demonstrating the relationship between frequency and the number of vibrational nodes. Ring diameter: 290 mm.

2185.10 Piano wire ring

Chladni plates

For use with 2185.00. A thin layer of fine sand is spread over the plate, and resonance patterns ("Chladni" figures) can be observed at certain frequencies. The plate resonances are audible.

2185.20 Resonance plate, square

2185.25 Resonance plate, circular

Flat springs for resonance experiments

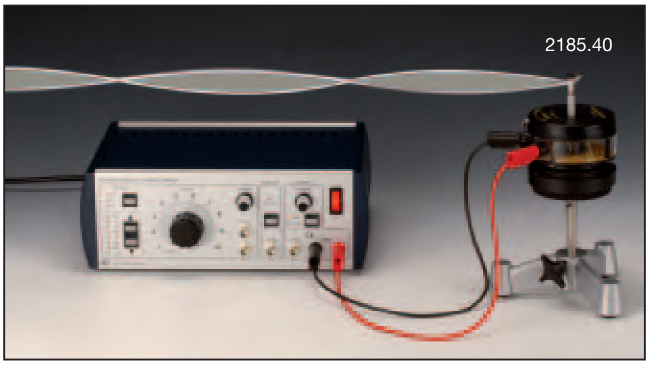
Various lengths. For use with the 2185.00. Fundamental frequencies at 11, 15, 21, 36 and 50 Hz can be readily observed. Interesting standing waves can be seen up to 300 Hz and heard up to 900 Hz.

2185.30 Flat Springs for resonance experiments

Longitudinal Wave Spring

155 mm long and 27 mm Diameter. Springkonstant 4,7 N/m.

2155.50 Longitudinal Wave Spring



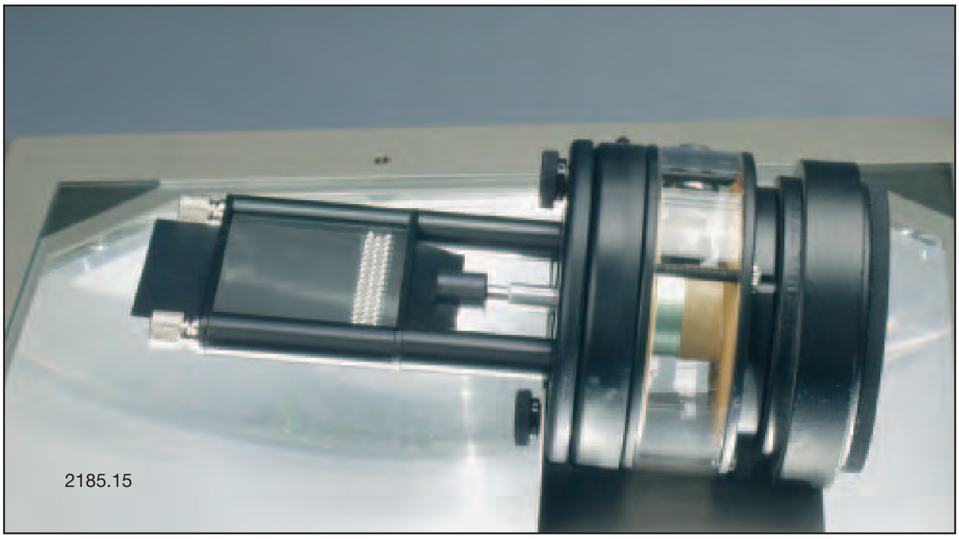
Rubber string

2 meters. For use with 2185.00 for demonstrating standing waves.

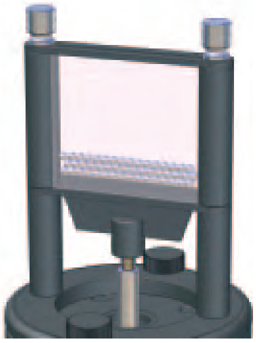
2185.40 Rubber string

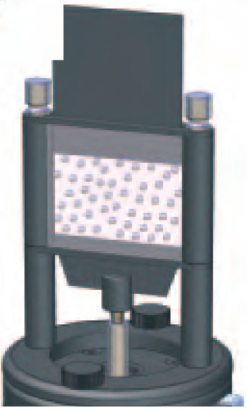
Gas model with piston

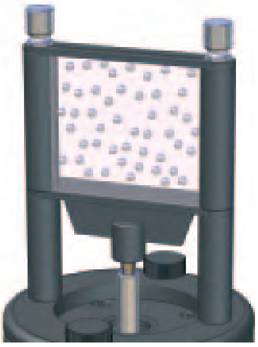
For use with the 2185.00. Ball bearings in motion represent gas molecules which lift a plastic piston due to repeated collisions. The model is supplied with the piston, balls and a support for placing the apparatus on an overhead projector.

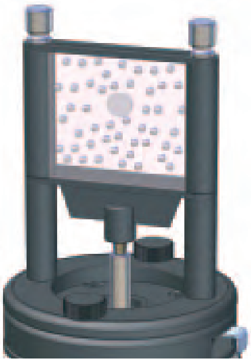


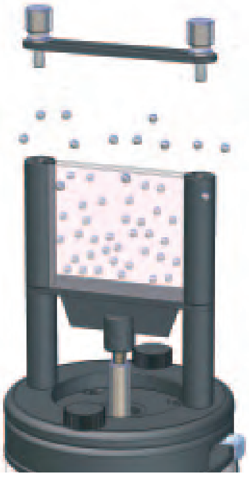
2185.55 Gas model with piston


Solids.


Gas in piston.


The gaseous state.

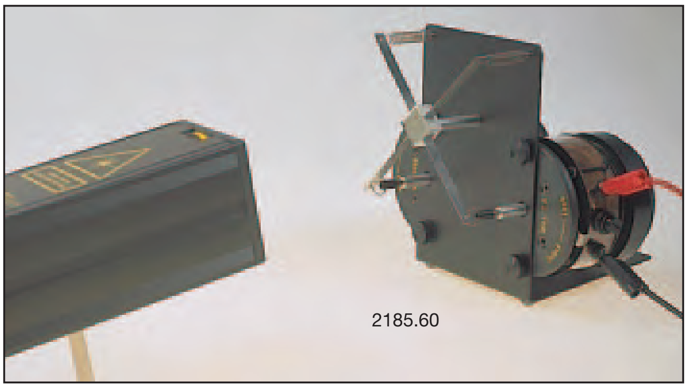

Brownian motion.


Boiling liquid.

Lissajous' apparatus

This apparatus is actually a simple oscilloscope. A mirror is mounted on a moveable steel ball held by two strips of spring steel. The two steel strips are spring loaded at one end and each controlled by a 2185.00 vibrator at the other. By regulating the oscillations with the two vibrators, one can control the motion of the mirror in two mutually perpendicular directions and thus control the laser beam reflected by the mirror. The light source can be a gas laser, a diode laser or similar light source. The vibrators, signal generators and light source are not included.

2185.60 Lissajous' apparatus

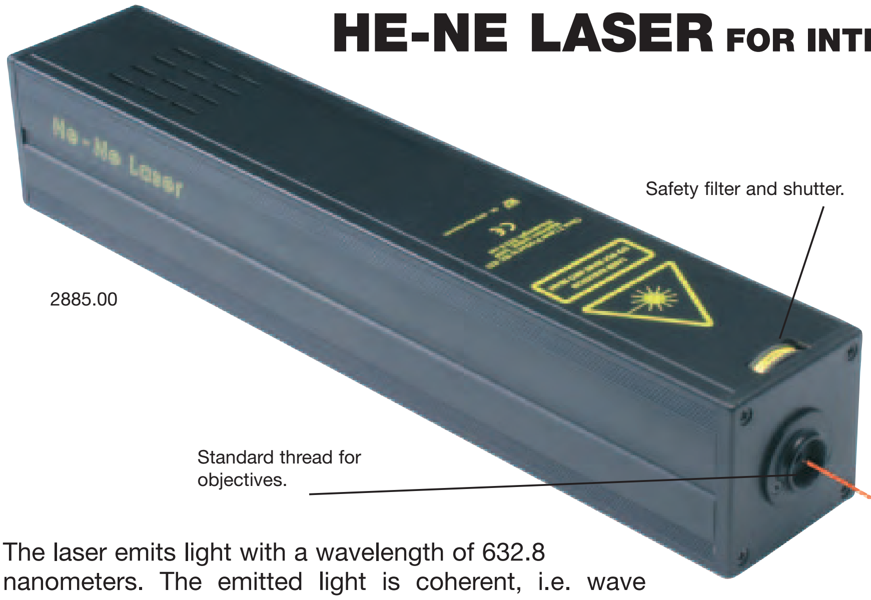


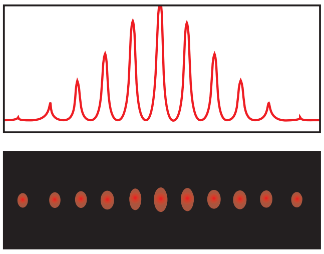
ADDITIONAL EQUIPMENT NEEDED

2 ea. Electromagnetic vibrators (2285.00)
2 ea. Signal generators (e.g. 2500.50)
1 ea. Laser (2885.00)

HE-NE LASER FOR INTERFERENCE EXPERIMENTS

HE-NE LASER 1 MW





The laser emits light with a wavelength of 632.8 nanometers. The emitted light is coherent, i.e. wave fronts propagate in the same phase over a large distance compared with ordinary light sources. The emitted light is highly directional and the beam diameter at the laser is about 0.5 mm increasing very gradually at increasing distances from the laser. The light emitted is not uniformly polarized but changes its polarization at random around the direction of propagation. Light from the laser is well-suited to demonstrations of optical interference. If a line grating is placed in the laser beam, the interference pattern will be clearly visible on a projection screen. The laser can be used for a wide range of applications in geometrical optics, holography, communication etc.

2885.00 He-Ne Laser, 1 mW
2885.10 He-Ne Laser, 2 mW

He-Ne laser, modulated, 1 mW

Laser like the 2885.00 but with the option of modulating the light beam. The laser is provided with a BNC-connector for connection to a signal generator, CD-player or similar signal source. The light beam intensity will then vary with the applied signal. Well suited for demonstration of optical communication using photodetector no. 4895.50.
Maximum modulation frequency: 1 MHz.

2885.20 He-Ne laser, modulated, 1 mW

4895.50
Fotodetektor

Photodetector

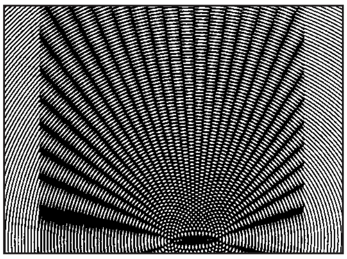
The photodetector is provided with a photo diode which can convert laser light intensity values to an electrical signal. The signal can be directed to the built in loudspeaker or be used for measurements via the analog and digital output connections. The photodetector can be used for demonstrating communication over a laser beam, fiber optic communication, plotting of interference patterns, etc. The maximum frequency is 1 MHz.

4895.50 Photodetector

Inteference pattern model for overhead projector

The set consists of two transparent plastic plates with printed wave front patterns for point sources on each plate. If the plates are placed on top of one another and slightly displaced, an interference pattern will appear. The pattern can readily be projected onto a large viewing screen using an overhead projector.

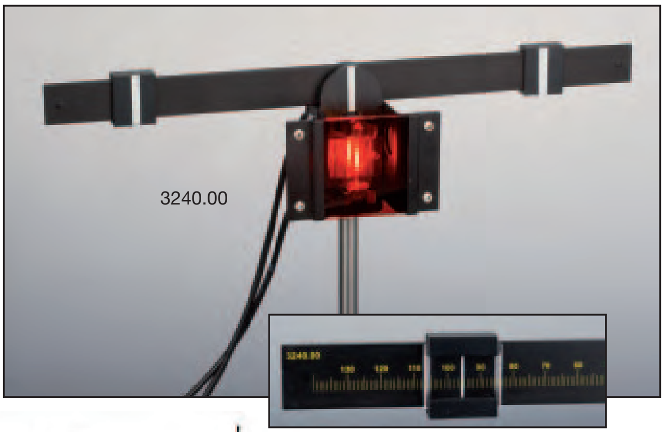
3235.00 Inteference pattern set

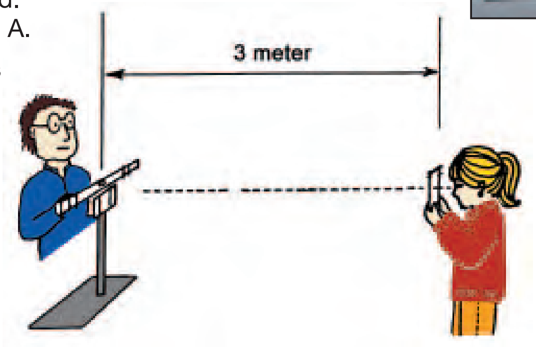


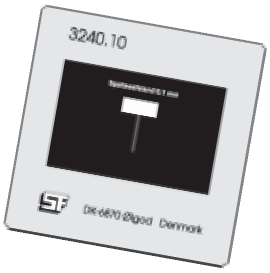
Wavelength of light apparatus

The apparatus is designed to measure the wavelength of light by studying the interference pattern from a double slit. The device contains a built in 12 V auto lamp with a holder for color filters and a millimeter scale with phosphorescent moveable markers. The emitted light is viewed at a distance of about 3 meters through a double slit. The viewer then directs a co-worker to adjust the markers on the millimeter scale so that the distance between them corresponds to 10 interference maxima. Afterwards the distances can be measured and the wavelength of the light can be calculated. The equipment is well-suited to student lab exercises. Red and blue color filters and a double slit are provided.
Power source required: 12 V AC/DC, 1.3 A.

3240.00 Wavelength of light apparatus


3240.00





Function generator - DC amplifier Frequency counter

Datalyse Compatible

2501.50

Three functions are built into a single instrument with a digital display. The simple and well-organized operating panel makes the unit well-suited for demonstration experiments and for student experiments with vibrations, waves and much more.

999.9
Frederiksen
Frequency Counter
Function Generator
Amplifier

Function generator

Sine, triangular and square wave signals with a broad, continuous frequency range are provided.
Digital fine-tuning of frequency and amplitude are provided. The BNC output signal connection (0-20 Vpp) is short-circuit protected. Up to 10 W of output power are available via the amplifier. It is possible to demonstrate frequency modulation by connecting an external signal.

DC amplifier

The short-circuit proof 10 W power amplifier has a frequency range from 0 - 50 kHz.
The amplifier can be used to amplify signals from the function generator or from external sources.
The input of external signals is via BNC connectors with an impedance of 10 kΩ, and the output signal is accessible via safety-type banana jack connectors.

Frequency counter

The meter is fully automatic, and it can measure external frequencies from 0.1 Hz to 150 kHz.

Serial computer interface

The instrument is supplied with a RS-232 serial computer interface which makes it possible to perform remote control and readout of the instrument. This can be accomplished via the standard terminal program in Windows or by means of the program Datalyse.

2501.50 Function Generator

2500.50

2500.50 Function generator

Function generator DC Amplifier

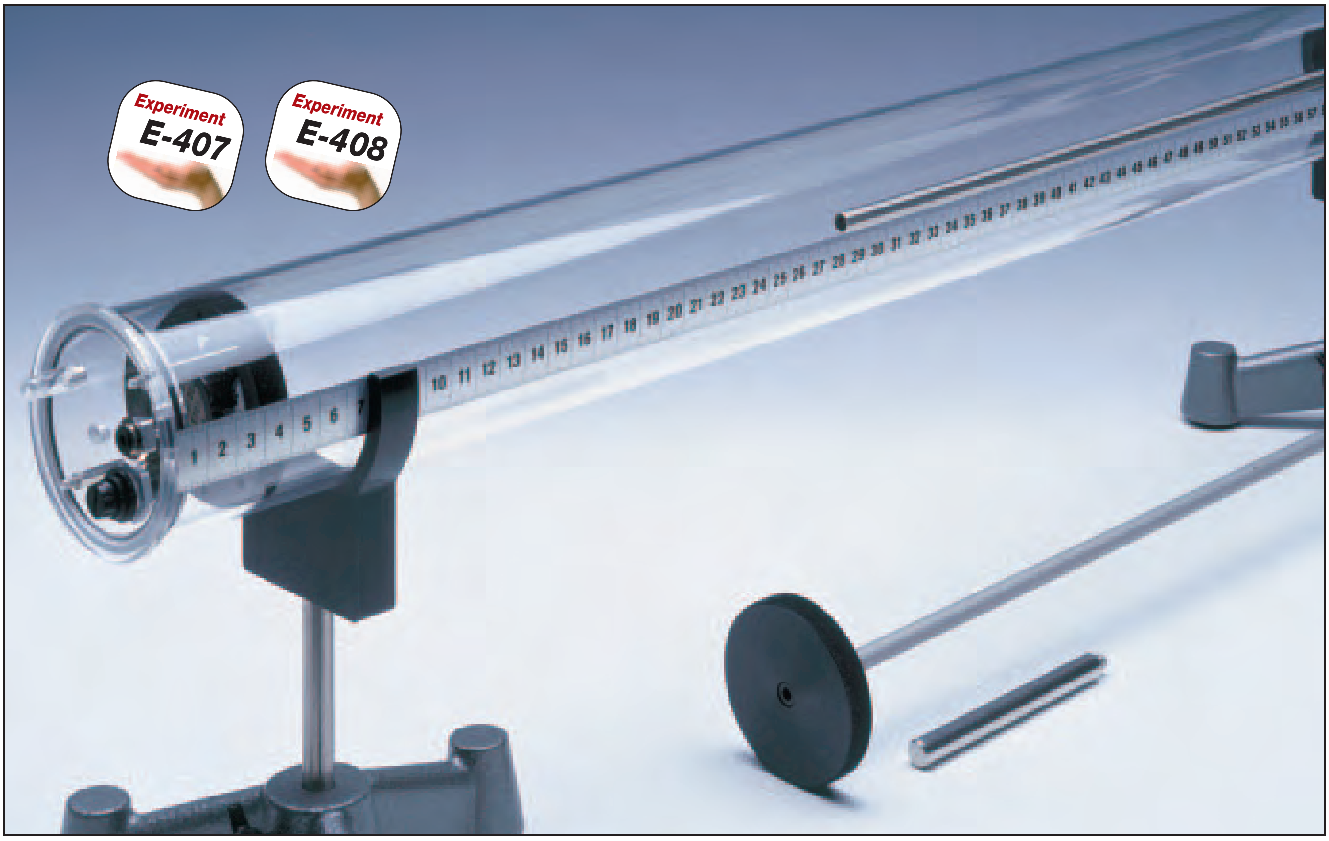
The function generator has a broad frequency range and a built-in power amplifier. The frequency range is divided into eight regions which can be adjusted and read off the adjustment knob scale. It is possible to perform frequency modulation (FM) and external control of frequency. The function generator is well-suited for use by both students and teachers.

- Sine, triangular and square wave signals.
- Short-circuit protected inputs.
- 10 W external/internal power amplifier.
- TTL signal output.
- FM modulation and frequency sweep within the performance range.

Function generators - technical specifications:

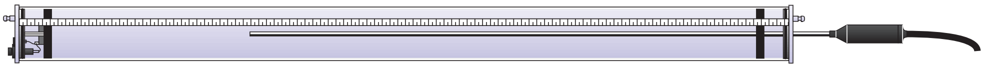
Instrument	**Function Generator DC Amplifier 2500.50**	**Function Generator DC Amplifier Frequency Counter 2501.50**
Frequency region	*0,1 Hz – 1 Hz 1 Hz – 10 Hz 10 Hz – 100 Hz 100 Hz – 1000 Hz 1 kHz – 10 kHz 10 kHz – 100 kHz 100 kHz – 1000 kHz 1 MHz – 10 MHz*	*0,1 Hz – 100 kHz in one range*
Signal type	*Sine, triangular, square wave*	*Sine, triangular, square wave*
Signal output: Output voltage Output impedance Distortion	*± 5.5 V pp and TTL 50 W < 1.3%*	*0-20 V pp 600 W typically 0.5 %*
DC Amplifier Frequency Range Output Power Output Voltage Input Impedance	*DC - 50 kHz at -3 dB 10 W RMS / 4 W ± 10 Vpp 10 K W*	*DC - 50 kHz at -3 dB 10 W RMS / 4W ± 10 Vpp 10 K W*
Modulator: Modulation signal FM Input voltage, sweep Sweep	*± 0-5 V ± 10 Vpp DC - 10 kHz*	*± 0-5 V*
Frequency counter: Measuring region Input impedance Max. input	*No*	*0.1 Hz - 150 kHz 200 k W ± 100 V*
Computer output	*No*	*RS 232 C*
Dimensions	*297 x 225 x 118 mm*	*297 x 225 x 118 mm*
Order number	**2500.50**	**2501.50**

Resonance pipe for sound experiments

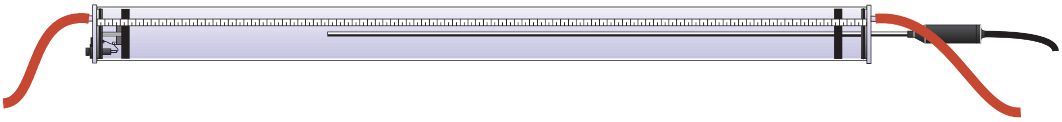


This resonance pipe provides many options for working with sound waves:

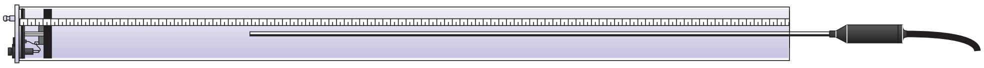
- Examine standing waves in a pipe open at both ends, closed at both ends or open at one end and closed at the other. Examine standing waves in a pipe closed at both ends while various gasses are pumped into the pipe.
- Vary the length of the half-open pipe by means of a piston (provided).
- The pipe consists of a plexiglas pipe with two end pieces with attachments for gas flow. There is a loudspeaker in one end.
- Dimensions: Length 100 cm. Diameter 7 cm.



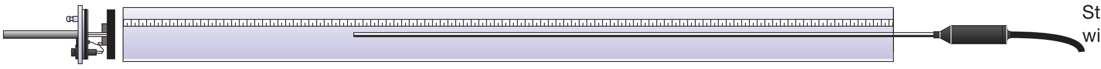
Standing waves in a closed pipe.



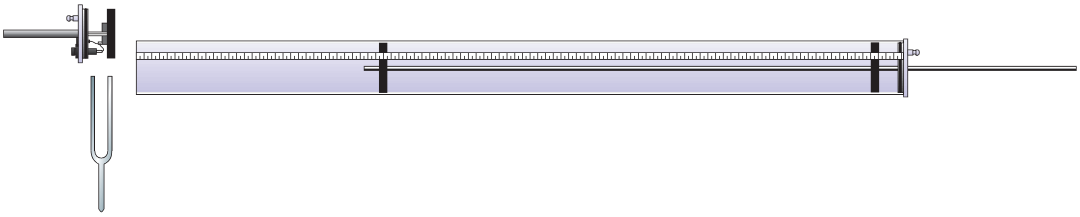
Standing waves in CO_2.



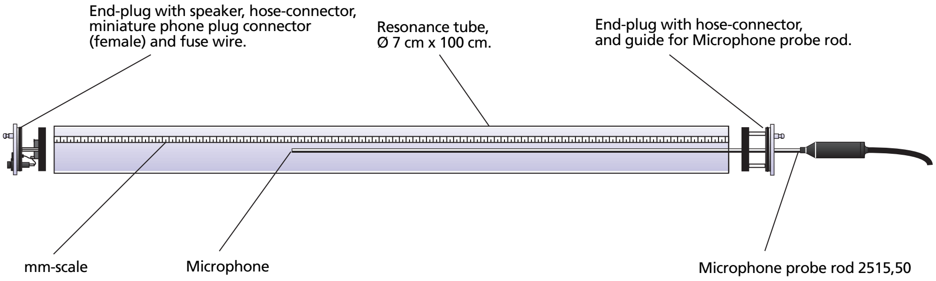
Standing waves in a pipe with open end.



Standing waves in a pipe with both ends open.



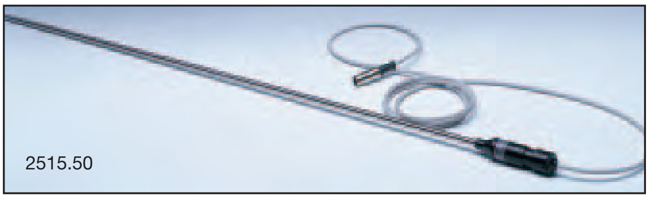
Regulation of the length of the air column.
A tuning fork or a loudspeaker can be used as the sound source.


End-plug with speaker, hose-connector, miniature phone plug connector (female) and fuse wire.
Resonance tube, Ø 7 cm x 100 cm.
End-plug with hose-connector, and guide for Microphone probe rod.
mm-scale
Microphone
Microphone probe rod 2515,50

2480.10 Resonance pipe (not including microphone probe and tripod supports)

ADDITIONAL EQUIPMENT NEEDED
2515.50 Microphone Probe
0006.00 Retort stand Base, Tripod

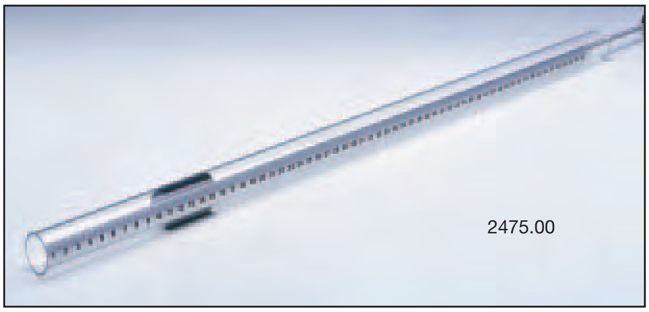
NB! The microphone probe is supplied with a DIN connector which is compatible with data logger interface, in case use of a computer is desired. If measurements are desired using an ordinary analog/digital meter or oscilloscope, type 2515.60 power supply box. If measurements are desired using an ordinary analog/digital meter or oscilloscope, type 2515.60 power supply box is required (also useful in other experiments).



Microphone probe

A miniature microphone is mounted at the end of a 740 mm long 8 mm diameter stainless steel probe for measurement of sound pressure levels in locations which are hard to access. The frequency range is 20 to 20,000 Hz. The probe is supplied with a 2 meter long cable with a DIN connector for use with the 2515.60 power supply.
The microphone can be connected to a voltmeter or oscilloscope via the 2515.60 power supply.
The probe is intended for use with 2480.10 resonance pipe.

2515.50 Microphone probe

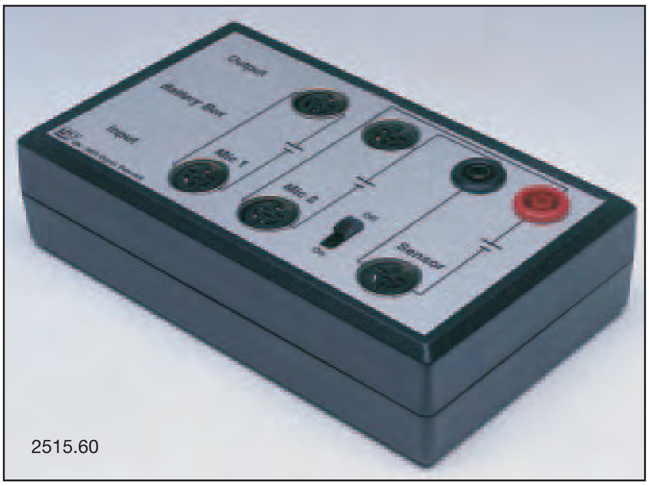


Kundt's resonance pipe

This apparatus is designed for demonstration of standing waves and for determination of the wavelengths of sound waves in air. The pipe is supplied with a millimeter scale and a moveable piston for changing the length of the air column. Dimensions: Length 66 cm, diameter 3 cm.

2475.00 Kundt's resonance pipe

ADDITIONAL EQUIPMENT NEEDED
Suitable tuning fork:
2240.10 Tuning Fork 1000 Hz
2245.61 Striking Hammer


Output
Battery Box
Input
Mic 1
Mic 2
On
Off
Sensor
2515.60

Power supply

The power supply is designed for use with microphones and other sensors which need a + 5 VDC to operate. The unit is provided with a battery compartment for 9 V alkaline battery type 6LR61 (3510.10) which via an electronic regulator supplies the +5 VDC supply voltage for connected probes. The unit has two input terminals with 6-pole DIN connectors (270 degrees) and one input terminal with a 6-pole DIN connector (180 degrees).
The output terminals for attachment of measuring devices are 3-pole DIN connectors and 4 mm jack connectors (safety type). When making measurements with the microphone probe 2515.10 if the connection is made to the input connector marked Mic 2, then an oscilloscope can be connected to the jack connectors.
Dimensions (LxBxH): 14.3 x 8.4 x 3.7 cm.

2515.60 Power supply

Microphone

The microphone is well-suited for the measurement of sound frequencies, the speed of sound and the recording of sound for Fourier transformation.
The sensitive microphone is very small and therefore very suitable for measurements of sound interference.
It is supplied with a one meter cable with a 3-pole DIN connector which can be connected directly to the electronic counter type 2002.50 or student timer 2006.60.
The microphone can be connected to an oscilloscope or other measuring instrument via type 2515.60 power supply. The frequency range is 20-20.000 Hz.
Supplied with 10 mm diameter support rod.
Dimensions: Length 105 mm, greatest diameter 30 mm.

2485.10 Microphone without stand

Microphone model "carbon box"

The apparatus is for demonstrating the operation of the carbon microphone.
The model consists of 2 ea. 45 mm diameter metal plates placed on either side of a layer of carbon grains. The metal plates are each connected to a telephone jack.
The system is mounted on a piece of clear acrylic so that all components are visible.

4680.00 Microphone model "carbon box"

2485.10

Carbon microphone

The device is used along with a power supply to produce an electrical signal by means of sound waves.
The microphone is mounted on a 10 mm diameter support rod and provided with a cable with banana jacks.
Maximum loading: 50 mA, 150 ohm. Dimensions: Length 155 mm, diameter 67 mm. Mass: 175 g

2490.00 Carbon microphone without stand

4680.00

2505.00

Loudspeaker

Used with function generator 2500.50 or 2501.50 to generate soundwaves from a point source of sound. Mounted on a 10 mm dia. rod, and supplied with cable, including 4 mm plugs. Power: 1W over 25 ohm.
Dimensions: Lgt. 165 mm, dia. 67 mm.
Mass: 0,2 kg.

2505.00 Loudspeaker without stand

2490.00

2510.50

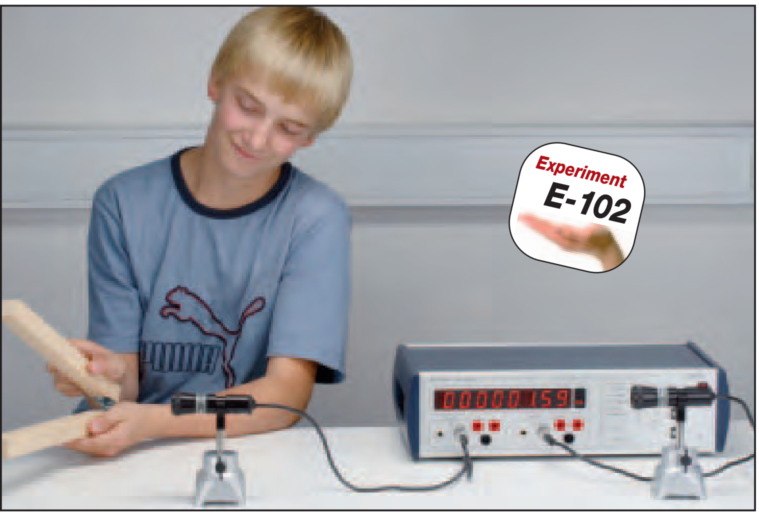
Loudspeaker

The speaker can be used with the type 2500.50 and 2501.50 signal generators for listening to acoustic signals. The signals can be measured using microphone type no. 2485.10.
The system contains three loudspeaker units.
Frequency range: 60 - 20.000 Hz
Loading: 50 W with 4 ohm impedance
Dimensions: B x H x D: 215 x 116 x 110 mm.
Weight: 2 kg.

2510.50 Loudspeaker without stand

Pendulum experiments.

Datalyse Compatible



Measuring the speed of sound.

Clapper board

This clapper board is ideal for producing the sharp sound pulse required for measuring the speed of sound.
Produced with two hinged hardwood blocks.
Dimensions: 27 x 50 x 300 mm.
Mass: 280 g.

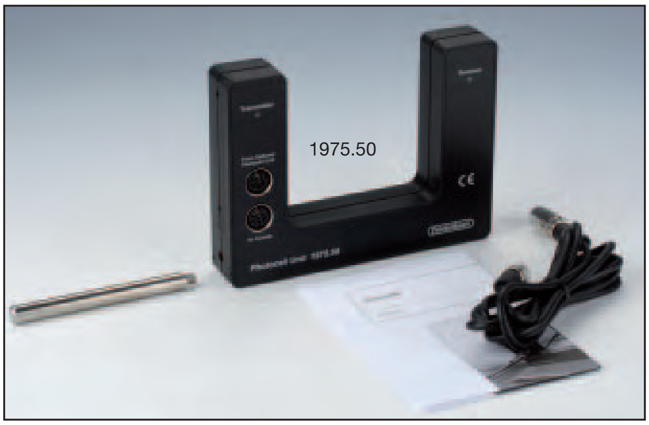
2482.00 Clapper board

Electronic counter

This microprocessor controlled 8-digit counter is designed for the measurement time intervals, periods of oscillation, rpm, frequency and for pulse counting, etc. The unit of measure is displayed, and it is possible to divide the display into two by 4 digits.
There are start/stop terminals for connecting microphones, photocell units, free fall equipment, etc.
There is a connection terminal for GM counters for measuring radioactivity with selectable gate times.
The counter is provided with an easily read LED display and a logically designed control panel. This makes the counter well-suited for demonstration experiments as well as for student laboratory exercises.
The counter has memory for storing measured values as well as an RS232 serial output for computer interfacing.
Time measurements can be made down to 1 ms, and frequencies up to 2 MHz can be measured.

2002.50 Electronic counter

See additional specifications on page 17.



Photocell unit

The unit is suitable for the measurement of pendulum periods, time interval measurements for experiments on an air track, measurements of periods of rotation, etc. The unit consists of a photocell which is illuminated via a one millimeter aperture by light from a light emitting diode. A red LED (light emitting diode) is provided next to the light source to indicate that the light source is on. A green LED near the photocell indicates when the receiver is illuminated. The photocell unit is provided with two 6-pole DIN-connectors for connection to the electronic counter no. 2002.50 and serial connection to additional photocell units, when signals are to be sent to the same input connection on the counter. The unit is manufactured in rugged plastic with threads for horizontal or vertical mounting using the 10 mm diameter mounting rod provided. A connector cable for the electronic counter is also provided. The maximum distance between the photocell and the light source is 90 mm. Dimensions: B x H x D: 160 x 120 x 28 mm. Mass: 450 g.

1975.50 Photocell unit including cable and mounting rod

Ball bearing track

The apparatus consists of a curved track mounted on a wooden support. It is used for experiments illustrating energy exchange between potential and kinetic energy. The curvature of the track can be changed by moving the wooden supporting blocks under the ends of the track.
Length of track: 495 mm.
Supplied with 1 ea. 16 mm diameter steel ball.

2170.00 Ball bearing track

2528.20

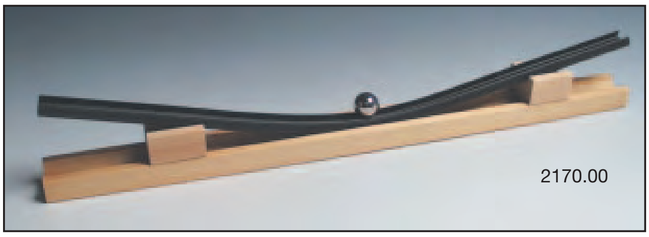
Sound level meter

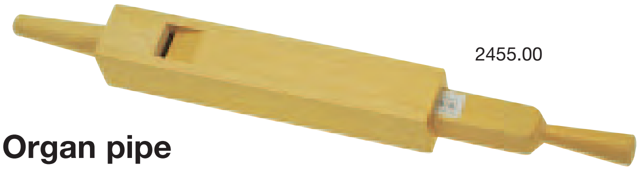
This instrument can be used to determine the sound level of a variety of sound sources. The sound level meter has a built-in microphone which has the same response as the average human ear. The sound level can be read off the built-in meter, which is provided with two scales: one for high and one for low sound levels. The instrument has a built-in reference sound source for calibration checking and a battery level check. The instrument is supplied with a case, a 9 V battery and instruction manual with sound level table.

Low range:	40 - 80 dBA SPL
High range:	80 - 120 dBA SPL
Dimensions:	160 x 65 x 38 mm.
Mass:	165 g

2528.20 Sound level meter

2528.30


2170.00

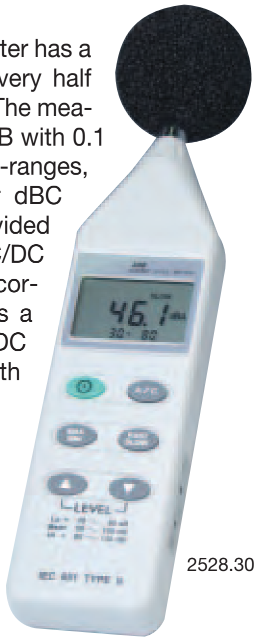

2455.00

Organ pipe

This apparatus is used to study acoustical properties. The device provides a good illustration of the relationship between frequency and the length of the pipe. The moveable piston has a scale showing tone levels.
The frequency range is from 400 - 800 Hz. The device is made of wood. Length 380 mm. Mass 250 g.

2455.00 Organ pipe

Sound level meter, digital


2528.30

This robust, user-friendly decibel meter has a 4 digit display which is updated every half second (for “fast” response mode). The measuring range is from 30 dB to 130 dB with 0.1 dB resolution. There are three sub-ranges, and the user can choose dBA or dBC weighting. The instrument is provided with a max/min feature and an AC/DC output for connection to a chart recorder or data collection unit. There is a connection for an external 9V DC power supply. Supplied in case with manual, battery and wind shield.

Technical Specifications:
Measurement range: 30-80dB, 50-100dB and 80-130dB.
Accuracy: +/- 1.5 dB.
Resolution: 0.1 dB.
Frequency range: 31.5 Hz - 8 kHz.
DC output: 10 mV/dB.
Impedance: 50 ohm.
AC output: 1 V RMS at full scale, impedance: 600 ohm.
Power supply: 9V block battery or line adapter.
Size: 275 x 64 x 30 mm. Mass: 280 g.

2528.30 sound level meter, digital

Tuning fork set C-scale, physical

The set consists of eight tuning forks from C(256) to C(512) manufactured in nickel plated steel with frequency values engraved. Supplied in carrying case.

2235.00 Tuning fork set, C-scale

2235.00

2220.00

Tuning fork for demonstration experiments

It is easy to hear an ordinary tuning fork but somewhat more difficult to show how it moves. The demonstration tuning fork oscillates at a frequency which is barely audible. On the other hand it is easy to observe its motion. Made of nickel plated steel. Length 75 cm.

2220.00 Tuning fork for demonstration experiments

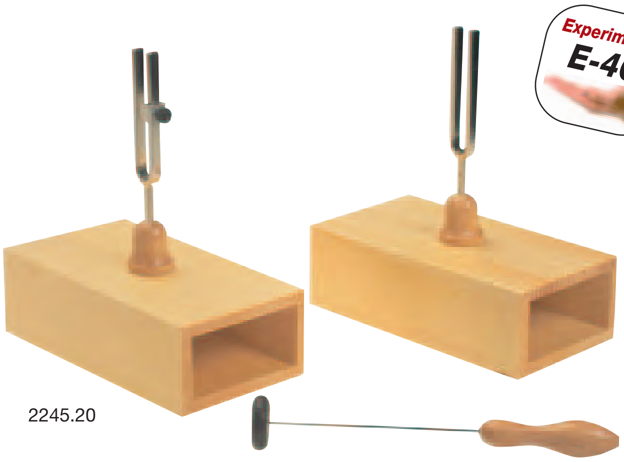
2450.00

Tuning fork with writing tip

Frequency 128 Hz. One arm of the tuning fork is supplied with a pointed tip for marking the oscillations on e.g. a soot-covered glass plate. Supplied with wooden handle. Overall length: 335 mm. Weight: 300 g.

2450.00 Tuning fork with writing tip

Experiment
E-402


2245.20

Tuning fork on resonance box

The tuning fork is manufactured in special nickel-plated steel. It is used for resonance and dissonance experiments. The resonance box is made of lacquered pine and supplied with thick felt pads on the bottom. It is supplied including a runner for mounting on one arm of the fork for changing the frequency. The standard frequency is 440 Hz. Set contains: Two tuning forks + boxes and a hammer.

2245.20 Tuning fork on resonance box

2240.00 -.10

Tuning fork, aluminum

The aluminum tuning fork is well-suited as a sound source for use with the resonance box due to its high sound power level. The lengths are 118 and 104 mm. Width: 30 mm. Mass: 97 and 87 g.

2240.00 Tuning fork, 1700 Hz

2240.10 Tuning fork, 1000 Hz

2225.00

Tuning forks, steel

These tuning forks are made of nickel plated steel with the tone and frequency engraved.

2225.00 Tuning fork 440 Hz. Length 120 mm

2230.01 Tuning fork 440 Hz. Length 145 mm

2230.05 Tuning fork 256 Hz. Length 170 mm

2230.10 Tuning fork 512 Hz. Length 140 mm

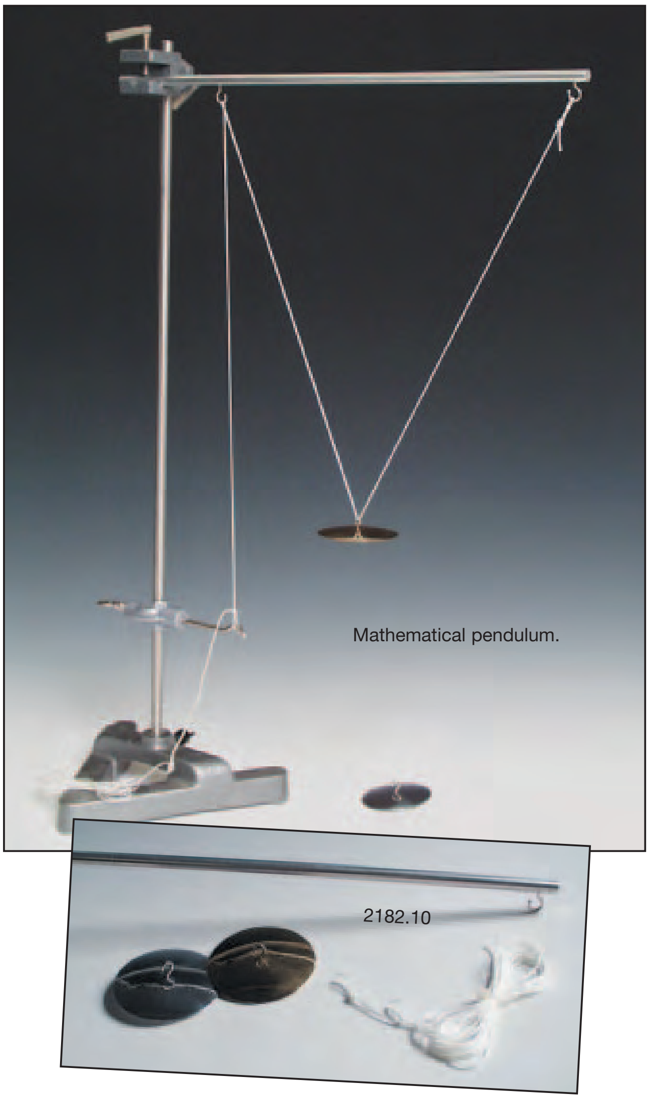
Prytz' oscillator

The apparatus is used to demonstrate Hooke's law and to study the harmonic motion of a spring-mass oscillator. The scale is provided with a mirror to help avoid parallax errors when making readings. It is supplied with a weight holder and four weights: 10, 20 50 and 100 g and three different sets of springs. It is designed for mounting on a standard 10 mm diameter support rod.

2180.00 Prytz oscillator

Additional Equipment Needed

0006.00 Retort stand base 1 ea.
0008.40 Retort stand rod 1 ea.


Mathematical pendulum.

Mathematical pendulum with support

The apparatus consists of two lens-shaped weights of different material but with the same physical dimensions, so that they have different masses but the same air resistance profile. Also supplied is a rod with hooks for two-point suspension and pendulum cord. The mathematical pendulum is a good approximation to the case of the "weightless" cord with all mass concentrated at the center of gravity of the pendulum bob. In this case the equation for the period is:
$T = 2\pi\sqrt{l/g}$, where T is the period, l is the length of the pendulum and g is the acceleration due to gravity.

2182.10 Mathematical pendulum with support

2155.40
2155.10-.30
2155.50

2160.00
2160.10
2177.00
2165.00

Steel ball with eyelet

Well-suited for use as a pendulum bob. Manufactured from polished, hardened steel with an aluminum eyelet.

2160.00 Steel ball with eyelet, dia. 28 mm, 96 g

2160.10 Steel ball with eyelet, dia. 20 mm, 33 g

Pendulum bob

Weights for experiments with pendulum oscillations, determinations of periods and frequencies of oscillation, energy conservation experiments, etc. Dimensions: 18 mm diameter, overall length 43 mm. The weight can be supplied in brass or aluminum with the same physical dimensions but with different masses.

2165.00 Pendulum bob, brass

2165.10 Pendulum bob, aluminum

Slot weights with holder

These weights are used for loading of springs or as pendulum weights where mass changes are to be studied 25 grams at a time. The weights are manufactured of nickel plated brass with a slot and a centre hole which retains the weights so that they do not fall off the holder.
Supplied with three weights of 50 g and one weight of 25 g. Overall weight including holder: 200 g.

2177.00 Slot Weights with holder

Spiral springs for experiments with elastic oscillations

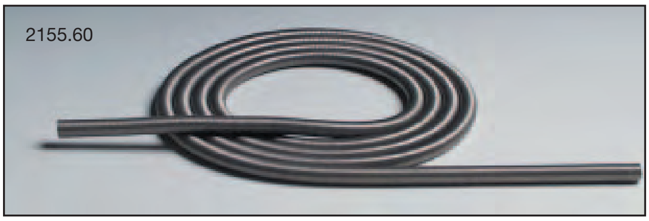
Product no.	Diameter	Length	Spring contant
2155.10	11 mm	32 mm	ca. 8.4 N/m
2155.20	11 mm	74 mm	ca. 3.2 N/m
2155.30	11 mm	115 mm	ca. 2.1 N/m
2155.40	31 mm	33 mm	ca. 5.0 N/m
2155.50	27 mm	155 mm	ca. 4.7 N/m

2155.10 – 2155.50 Spiral springs

Spiral spring "Slinky"

Is used for demonstration of longitudinal vibrations
Length: 150 mm.
Diameter: 75 mm.

2155.70 Spiral spring ”Slinky”



Spiral spring, 2 meter

The spring is used for demonstrations of transverse oscillations and for producing standing waves.
Length, unloaded: 200 cm. Diameter: 10 mm.

2155.60 Spiral spring, 2 meters

Slot weights with holder

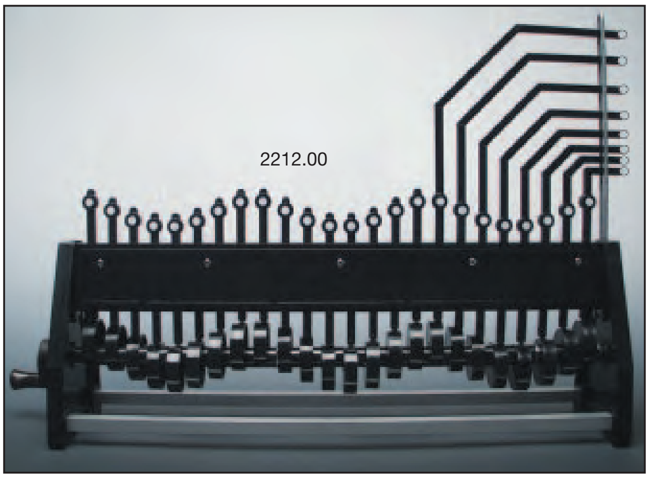
The weights are manufactured of brass with engraved mass and a centre hole which retains the weights so that they do not fall off the holder. The set contains 1 ea. 50 g, 9 ea. 20 g, 1 ea 10. g and 2 ea. 5 g

2177.10 Slot weights with holder

Wave machine

The apparatus is used for demonstrating longitudinal and transverse oscillations. It is supplied with a drive shaft with a crank which acts on a number of vertical rods as it rotates. Each rod has a white dot marking at the top. The last eight rods are supplied with an angular extension which makes it possible to observe corresponding longitudinal and transverse waves. A 360 degree scale is mounted by the hand swing so that the phase angle can be read off. Dimensions: (LxHxD) 48 x 32x10 cm. Mass: 1 kg.

2212.00 Wave machine



Wave apparatus for transverse waves

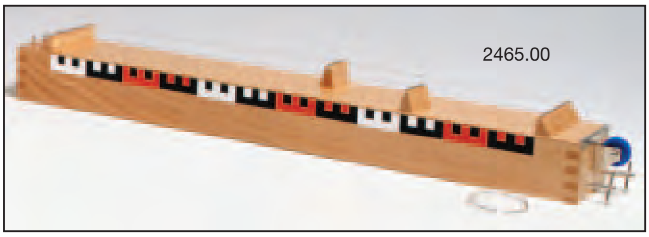
This is a very illustrative piece of equipment for demonstrating transverse wave motion. It consists of 35 massive metal rods 46 cm long suspended in the middle by a metal wire. The inertia of the system ensures slow and easily studied wave motion, for the metal rods are provided with a yellow rubber marking at each end (contrasting with the black color of the apparatus). The apparatus provides an excellent illustration of the concepts of wavelength, frequency, amplitude, reflection and phase. Size: 90 x 46 x 30 cm.

2212.10 Wave apparatus for transverse waves

Set of 5 springs with hook

Set of five springs of equal length but with various spring constant. With eye-let and hook.

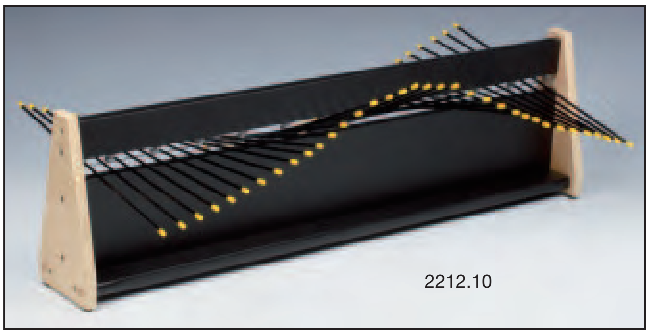
2155.80 Set of 5 springs with hook



Trichord

For experiments with oscillating strings. The apparatus is a wooden box with facilities for supporting strings under tension. One string is placed under tension using weights, while the two others can be stretched using a tightening key. the apparatus can be used to illustrate how the pitch of a tone depends upon the length of a string and its tension. Provided with a centimeter scale and with two steel and one nylon string. Length: 60 cm.

2465.00 Trichord

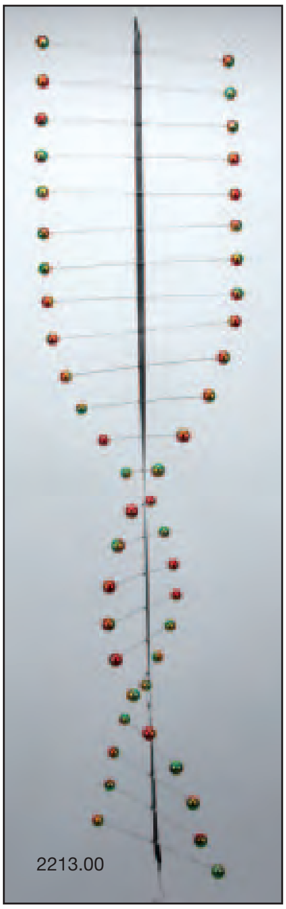


Wave apparatus (low cost) for transverse waves

Illustrates vertically moving transverse waves. The 28 arms extend from a central band of neoprene rubber which provides flexibility and a small amount of damping. A wave front can be followed through the first reflection, but dies out relatively fast when it returns to the bottom of the apparatus. Ideal for demonstration of the properties of waves.

Placed between two sheets of paper or cloth, the apparatus can easily be rolled up for storage

2213.00 Wave apparatus for transverse waves



Heat

Thermometer

Lab thermometres with blue mercury filling on a white scale

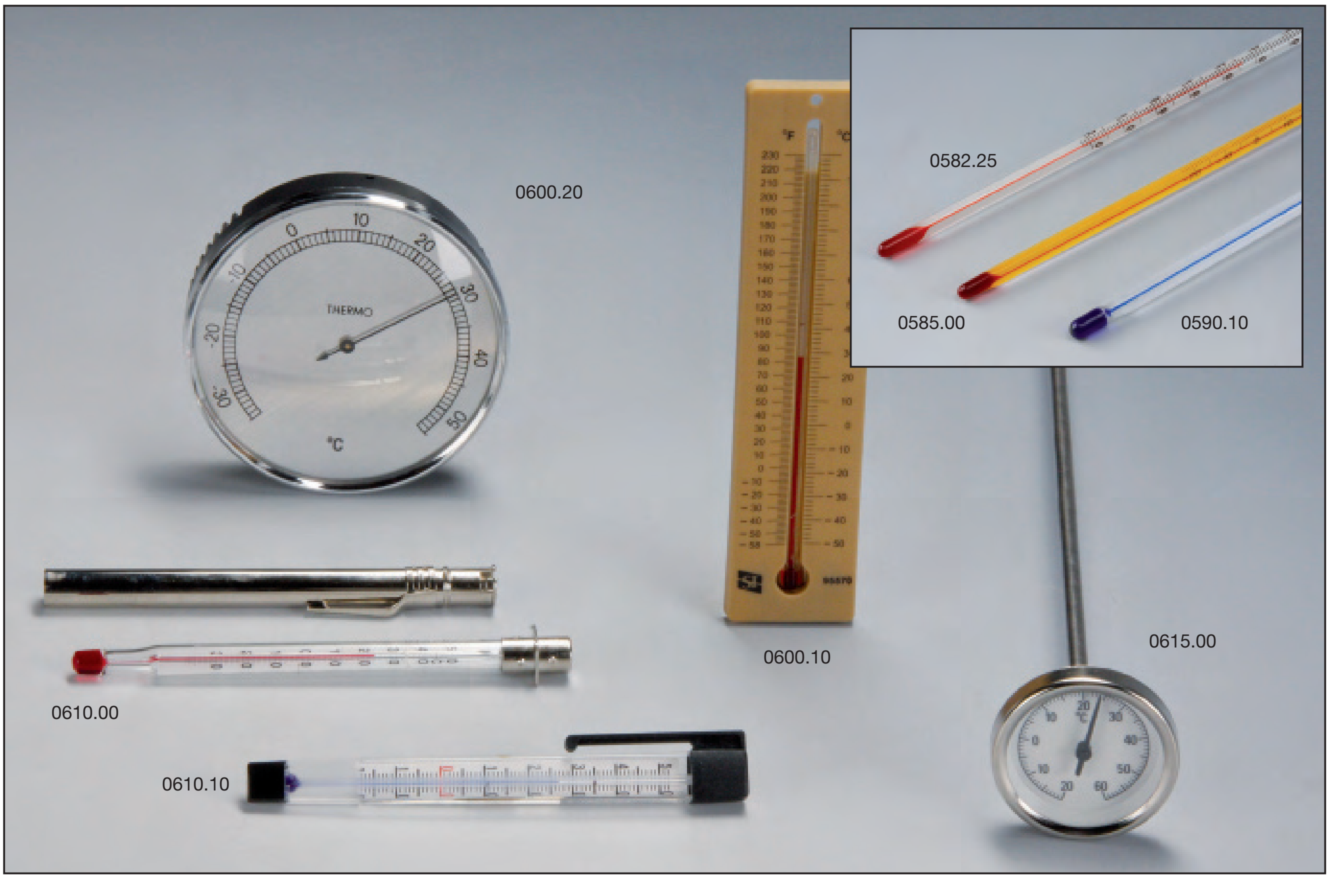
Article no	Temperature range	Resolution	Length	Diameter
0575.10	-20 - +110	1/1	260 mm	8 mm
0575.20	-20 - +360	1/1	340 mm	7,5 mm
0575.40	-10 - +52	1/10	405 mm	10 mm
0575.70	-2 - +102	1/5	400 mm	10 mm
0575.80	-10 - +101	1/10	600 mm	9,5 mm
0580.10	-10 - +625	2/1	450 mm	6,5 mm

0580.10
0575.80
0575.70
0575.40
0575.20
0575.10

Thermometer, Galilei

Thermometer using the principle of specific gravity as function of temperature.
Temperature range 18 - 26
Actual temperature can be seen on the lowest of the floating balls.
Height 28 cm.

0600.02 Thermometer, Galilei



Low cost thermometer

Red alcohol filling on a white scale.
Range -20 - +110 Resolution 1/1 Length 300 mm diameter 7 mm.

0582.25 Low cost thermometer

Thermometer, prismatic

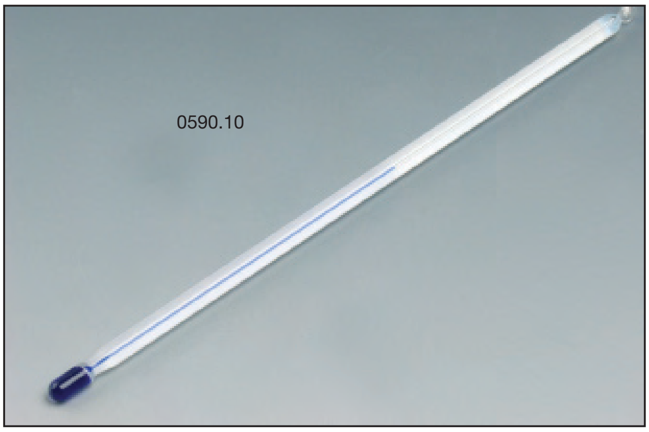
Red alcohol filling. Solid glass with yellow scale. Range -20 - +110 Length 275 mm.

0585.00 Thermometer, prismatic

Thermometer without scale

Blue alcohol filling.
Range approx. -10 - +110 Length 260 mm.

0590.10 Thermometer without scale



Thermometer with plastic scale

Range -40 - +110.
Red alcohol filling. Sturdy thermometers suitable for youngest classes.
Can be used in boiling water.

0600.10 Thermometer with plastic scale

Prismatic thermometer in metal housing

Range -32 - +50 Red alcohol filling.

0610.00 Prismatic thermometer in metal housing

Low cost prismatic thermometer in plastic housing

Range -20 - +50 Blue alcohol filling.

0610.10
Low cost prismatic thermometer in plastic housing.

Thermometer for measuring soil temperature

Range -10 - +60 Scale diameter 50 mm Stainless steel. Length of spear 500 mm.

0615.00
Thermometer for measuring soil temperature

In-door thermometer

Range -35 – +55. Diameter 100 mm.

0600.20 In-door thermometer. Range -35 - +55

Digital thermometer type 305

A handy and robust digital thermometer supplied with a blue rubber protective case, fold out stand and carrying handle. The thermometer can measure temperature with an accuracy as high as 0.1 degree C. A “hold” function is standard, and a maximum value button is provided, causing the highest temperature during a measuring session to be recorded.

Temperature range:	-50.0 to +1300 degrees C. -58.0 to +2000 degrees F.
Resolution:	0.1 or 1 degree C.
Display:	3 ½ digits liquid crystal display with maximum readout value of 1999.
Accuracy:	+/-(0.3 rdg + 1 degree C) -50 to +1000 deg C. +/-(0.5 rdg + 1 degree C) 1000 to 1300 deg C.
Update rate:	2.5 times per second.
Size:	147 x 70 x 39 mm.
Mass:	210 g.
Battery:	9 V IEC 6F22 (SF 3510.10).
Temp. probe:	Ni-Cr-Ni type “K” (se below). One wire-type thermocouple included.

2606.10 Digital thermometer

2606.15
2606.52
2606.50
2606.51

Digital thermometer type 307

As described above but with two type K thermocouple input connectors. The instrument can also display temperature difference. Two wire-type thermocouples included.

2606.15 Digital thermometer, two inputs

Thermal sensors

Robust and inexpensive type K thermocouples supplied with flat jacks and strong spiral cord connection lead. Can be used for all instruments requiring this type of thermocouple.
Liquid sensor, stainless steel, sensor size: 105 mm x 3 mm diameter. Measuring range -50 to 800 degrees C.

2606.50 Liquid sensor

Liquid sensor, stainless steel, sensor size: 200 mm x 3 mm diameter. Measuring range: -50 to 800 degrees C.

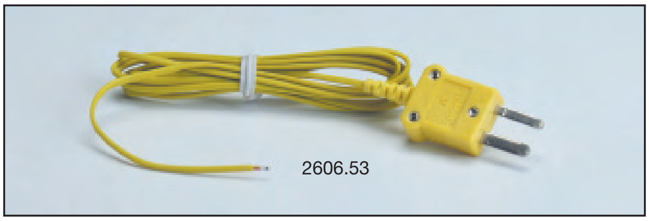
2606.51 Liquid sensor

Air sensor, stainless steel, sensor size: 200 mm x 8 mm diameter. Measuring range: -50 to 800 degrees C.

2606.52 Air Sensor

Wire sensor, 120 cm long wire, measuring range: -50 to 200 degrees C.

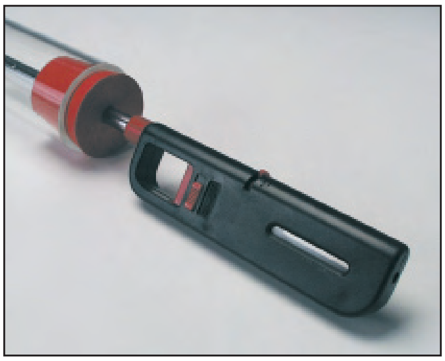
2606.53 Wire sensor



Gasoline cannon

This demo illustrates the explosive power of hydrocarbons. The apparatus consists of a plexiglas tube in which a piezoelectric spark generator is mounted in a rubber stopper in the bottom. The inner side of the tube is moistened with a small amount of gasoline, and the cork stopper at the top is put in place. When the spark generator is activated the explosive mixture of gasoline fumes and air is ignited, and the cork stopper is fired from the top of the tube. Size: 710 mm x 52 mm diameter. Mass: 480 g.

2648.00 Gasoline cannon



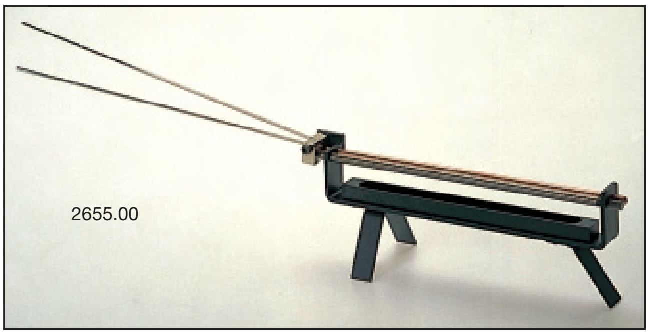
Pneumatic lighter

For demonstrating temperature increase when a confined gas is compressed. If an inflammable material is placed in the transparent cylinder, it will ignite when the piston is pressed to compress the gas. The lighter consists of the cylinder with piston. Included are a bottom plate with cylinder, O-ring lubricant, extra O-rings and inflammable material. Supplied with user instructions.

2649.00 Pneumatic lighter

Thermal expansion apparatus

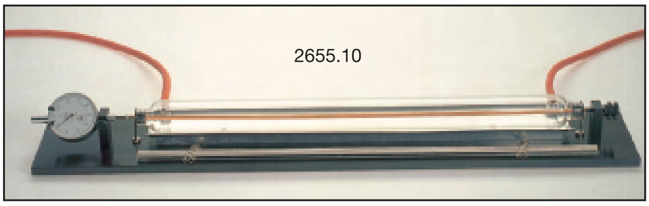
For demonstration of the linear expansion of solids. Two metal rods are placed over a container which is filled with spirit and then set alight to heat up the rods. The linear expansion is measured by means of two mounted pointers bearing against the ends of the rods. The pointers can be set at zero by rotating the rods, which are threaded at one end. The metal rods are made of iron and copper. Total length excl. pointers: 220 mm.



2655.00 Thermal expansion apparatus

Thermal expansion apparatus

Precision dial-indicator form. By using a dial indicator to measure the changing length, this apparatus provides very accurate determinations of the coefficient of linear expansion. The indicator reads directly 0.01 mm.
The heating takes place by passing water vapour through the glass jacket. The unit is supplied with 4 rods, one of copper, aluminium, glass and iron. Overall length of the apparatus 650 mm.

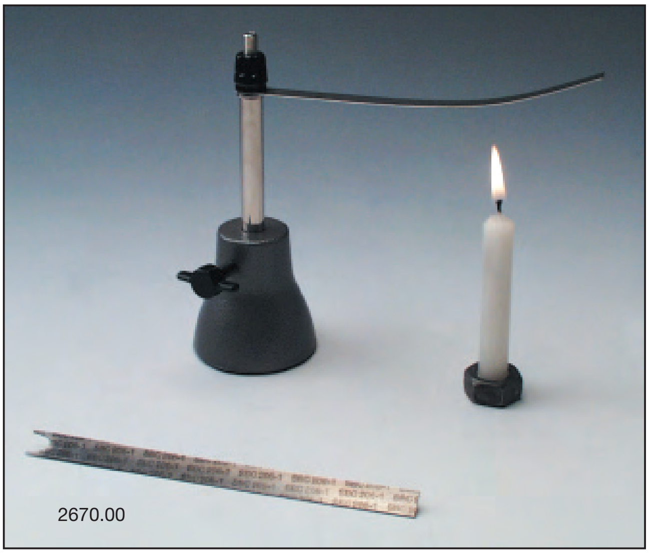


2655.10 Thermal expansion apparatus

Bar breaking apparatus

For demonstration of the effects of expansion and contraction. Supplied with 10 cast-iron rods, which by heating or cooling of the app. centre rod can be broken due to the centre rod's expansion or contraction.
Overall length: 320 mm.

2660.20 Bar breaking apparatus



Bimetalic strips

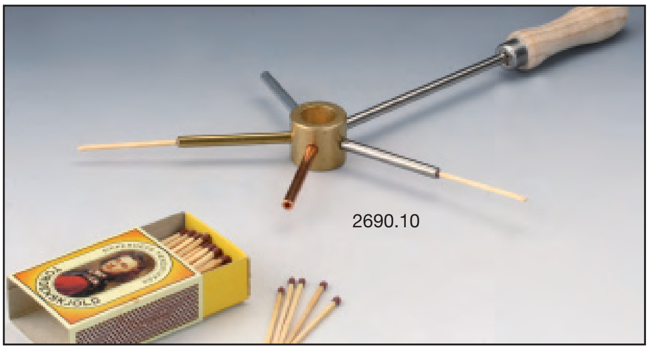
The strips are supplied with an indentation for mounting under af fastening screw. Size: 0.5 x 10 x 150 mm.
Mass: 6 grams.

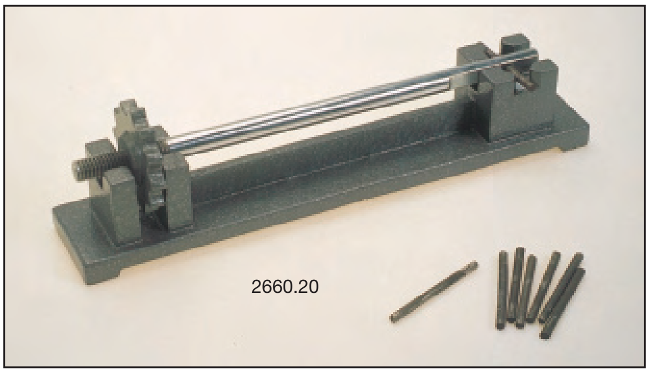
2670.00 Bimetalic strips

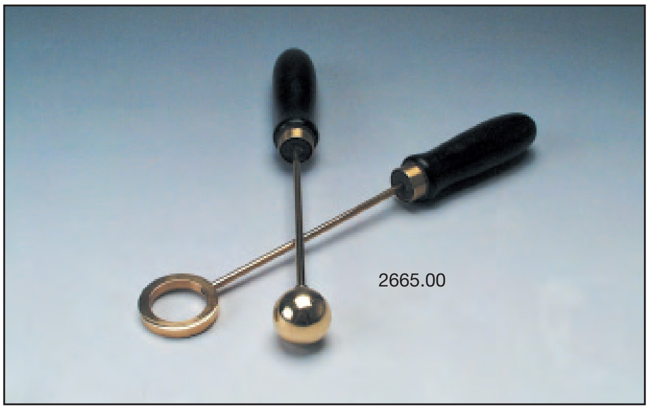
Material samples

The set consists of eight rods. It is used e.g. for demonstration of the various heat conductivities of these materials. They can also be used for experiments with density. All the rods have the same (2 cm^3) volume. They are made of aluminum, lead, nylon, glass, rubber, iron, copper and brass. Supplied in a plastic box with clear lid. The rods are 120 mm long. Mass: 130 g.

2690.00 Material samples







Ring and ball

For demonstration of heat expansion of solid bodies. Consists of a brass ring and ball mounted in wooden handle.

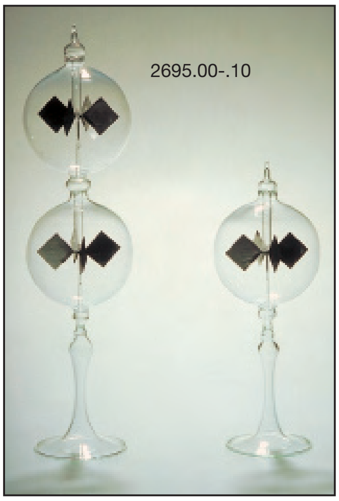
2665.00 Ring and ball

Conductometer

The different rates at which heat flows in various metals are shown by this device. Four rods of different metals (brass, copper, aluminium and iron) have one end clamped in an iron ring mounted on a rod with wooden handle. The four rods have hollow ends where a match can be inserted, and sulphur placed in the central hole. When heated, the matches will "light" in order of thermal conductivity of each rod.

2690.10 Conductometer

Radiometer



The device demonstrates the conversion of radiation energy to kinetic energy. There is a very slight amount of air inside the glass globe in which four uniform mica plates are supported on a needle bearing like a mill wheel.
Differential heating causes the little mill wheel to rotate when exposed to radiation. Sphere diameter: 70 mm. Stand diameter: 60 mm. Height: 210 mm. Mass: 62 g.

2695.00 Radiometer

Radiometer, double

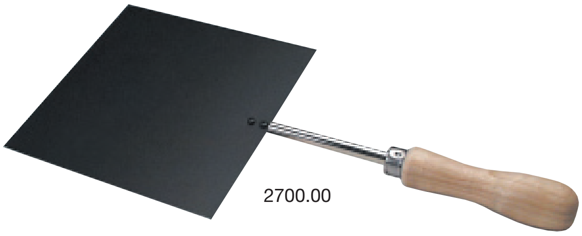
As item no. 2695.00 but with two glass spheres on top of one another with mill wheels designed to rotate in opposite directions. Sphere and stand diameters: 70 mm. Height: 290 mm. Mass: 105 g.

2695.10 Radiometer, double

Heat radiation plate

The plate is used to demonstrate the importance of the surface properties for heat radiation. The steel plate has one size blank metal and the other side painted black. It is mounted on a nickel plated shaft with a wooden handle. The plate is first heated, then the metal plate is held close to your cheek: first one side then the other. A heat radiation detector item no. 2872.81 can also be used (page 62). The plate size is 175 x 175 mm with a thickness of 1 mm. Length: 370 mm. Mass: 370 g.

2700.00 Heat radiation plate



Cylinders

Specific heat capacity specimens, set of three metal cylinders made of lead, brass and aluminium. Weights respectively 200 g, 200 g, and 100 g. Diameter: 25 mm.

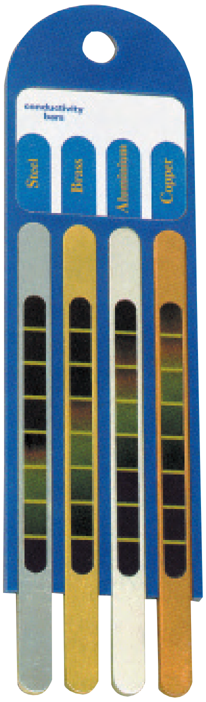
2725.00 Cylinders

Heat radiation discs

2710.10
30
35
40
45
50
55
60
65
REMOVE DISC WHEN
STOP
APPEARS

Four thin aluminum discs anodized on one size with flat black, glossy black, flat silver and glossy silver finish are supplied. These four surfaces absorb heat differently. The temperatures of the discs can be observed on the opposite sides on which liquid crystal temperature indicators marked in intervals from 30 °C to 65 °C have been mounted. The discs can also be placed directly on a hot body to thereby measure temperature.
The low heat capacity assures a very low response time and quick cooling for repeated experiments. The discs can be reused again and again.
Supplied in a box along with an insulating acrylic support with permits handling without heating from the hands.

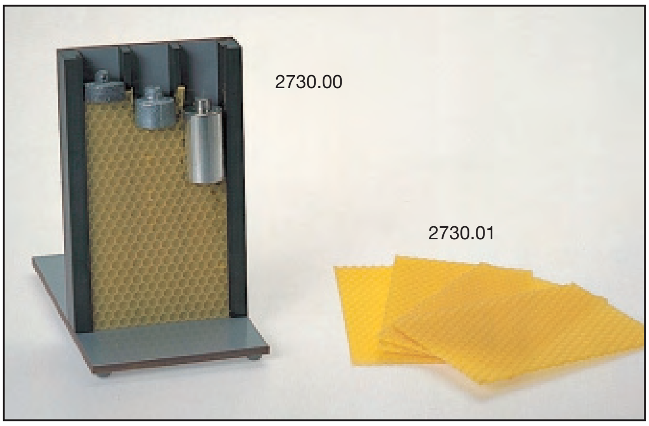
2710.10 Heat radiation discs



Heat conductivity rods

The apparatus consists of four metal rods made of steel, brass, aluminum and copper mounted in the same plastic support. Each of the rods is provided with a liquid crystal indicator for showing temperature variations up through the rod. The liquid crystal shows the color green at about 40 °C, and this green area moves up the rod as heat is transported. In this manner the different heat transport properties of the these materials is demonstrated. When the rods have cooled off, they are ready for a new experiment. They can be reused again and again.

2692.00 Heat conductivity rods



Specific heat apparatus

The unit consists of a holder where wax plates and three metal weights with equal weight and diameter can be located. The weights are made of aluminium, lead and zinc. The weights are heated to the same temperature and located over the wax plate.
Due to differences in the specific heats of the weights, they will melt to various depths. Incl. 5 wax plates.

2730.00 Specific heat apparatus

Spare part

Wax plates.

2730.01 Spare part

2740.05
2740.00

Calorimeter, aluminium

Diameter 70 mm, height 90 mm. Outer vessel separately heat insulated by means of plastic cones.

2740.00 Calorimeter, aluminium

Stir for calorimeter

Made of nickelplated brass

2740.05 Stir for calorimeter

Joule's apparatus

For the determination of the specific heat capacity of liquid by the electrical method. Used together with calorimeter no. 2740.00. The resistance of the two constantan coils are 2 x 2.5 ohms. Lid made of plexiglass with a hole for the thermometer.

2740.10 Joule's apparatus

2,5 Ω
2,5 Ω
2740.10

Immersion heater

This is used with the insulated cups item no. 2745.00 for confirmation of Joules law. The plastic lid has a center hole for a thermometer. Mounted with 2.2 ohm heating element connected to two standard 4 mm jack receptacles. Diameter: 65 mm. Height: 75 mm. Mass: 30 g.

2745.10 Immersion heater

Insulated cups

These thermal cups (25/package) are useful for experiments with specific heat. They will fit item no. 2745.10. Height: 85 mm. Upper diameter: 75 mm. Volume capacity: 180 ml.

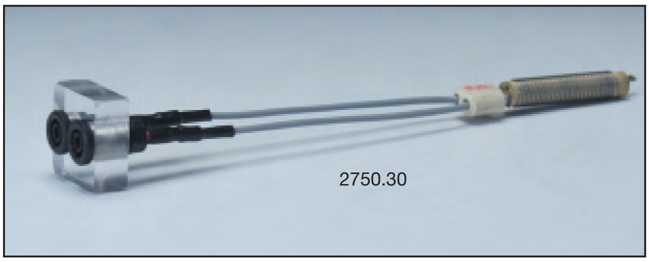
2745.00 Insulated cups

2745.00
2745.10

Immersion heater for low voltage

Immersion heaters for low voltage. Suitable for test tubes with 30 mm outside diameter. Length of the heater 240 mm.

2750.20 Immersion heater 2,5 Ohms
2750.30 Immersion heater 5 Ohms



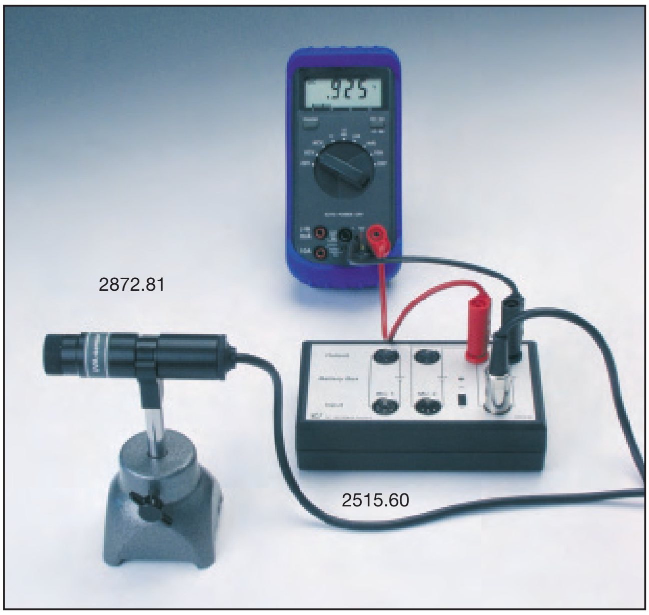
Heat radiation detector

This sensor is sensitive to electromagnetic radiation in the wavelength region from 0.25 µm to 20 µm, i.e. from the ultraviolet through the visible to the far infrared. Thus it is sensitive to thermal radiation in the near IR (0.3 - 3 µm) and far IR (3 µm - 20 µm) regions. Because the sensor uses a black absorbing surface and a thermopile detector, the response of the sensor is uniform over its wavelength range. The output signal is proportional to the incident power per unit area striking the detector surface. The sensor is adjusted so that an output of 4 V corresponds to 1000 W/m^2 +/-3%. The cable is terminated in a 5 pole male DIN connector compatible with computer interface.

The sensor can also be used along with the battery box accessory, item no. 2515.60 (see page 85), to provide the necessary 5 V DC bias voltage. When using the battery box an ordinary digital voltmeter can be used to read the output signal.

Supplied with a holder with a 10 mm diameter rod for mounting on a laboratory stand.

2872.81 Heat radiation detector



Leidenfrost dish

The apparatus is a dish made of steel. The dish is heated up to several hundred degrees Centigrade, and a few drops of water are put in the dish. Some of the water remains liquid even though the boiling point of water is exceeded. The liquid forms a small sphere which moves about on a pillow of steam. The experiment demonstrates the poor conductivity of steam and also the high surface tension of water. The dish diameter is 56 mm, and it is 6 mm high. Mass: 85 grams.

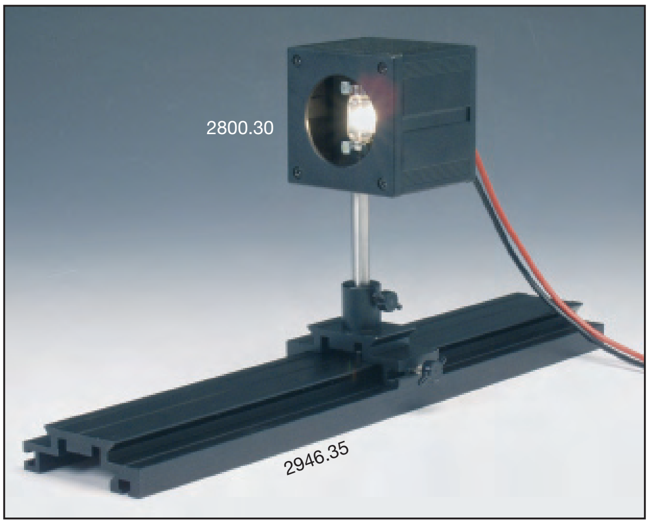
2635.00 Leidenfrost dish

Optics

Student reuter lamp

This simple, high intensity light is very suitable for experiments with lenses, prisms and optical gratings. The light source itself is a small, long-filament lamp with the filament aligned with the supporting rod making it easy to position on an optical bench. The long, narrow filament is ideal for performing experiments with lens optics and gratings. The lamp housing is supplied with a cooling fan which keeps the housing cool enough to touch even though the lamp is rated at 15 watts of electrical power.

2800.30 Student reuter lamp



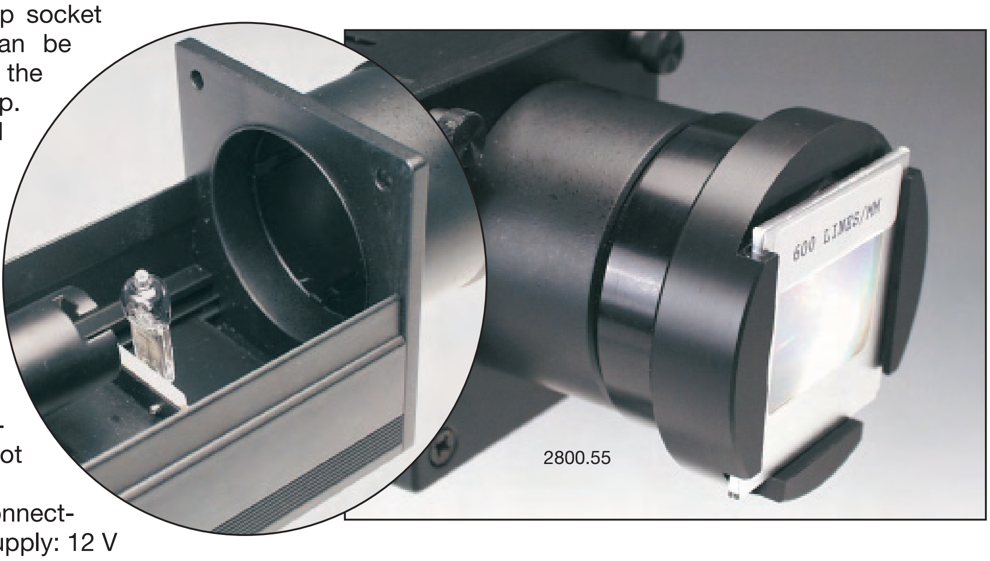
Experiment Lamp
12 V AC/DC

Experiment lamp

This lamp emits a bright, straight beam of light which is ideal for many types of experiments and demonstrations.
Both focus adjustment and the horizontal placement of the lamp socket within the lamp housing can be done by displacing or turning the handle at the back of the lamp.
The Reuter Lamp is supplied with a bayonet socket for standard, clear, incandescent 12 V/35 W lamps (item no. 4270.10) and a two pole socket for halogen lamps 12 V/50 W. During operation the lamp housing is ventilated by means of a built-in ventilator, so that the surface temperature of the housing will not exceed 60 °C.
Supplied with safety jack connectors for attaching the power supply: 12 V AC/DC, 3 - 4.2 A.
Supplied with a 10 mm diameter mounting tap appropriate for use with an optical bench or with a laboratory stand. A 50 W halogen lamp is supplied (item no. 4270.10). Length: 310 mm. Width: 76 mm. Height: 105 mm (excluding mounting tap). Mass: 1.2 kg.

2800.50 Experiment lamp

Experiment Lamp
2800.50



Aperture holder for experiment lamp

Holder for apertures, color filters, etc.
The aperture holder can be mounted on the lens mount. It is rotatable and can be used for apertures or filters mounted in standard slide frames.

2800.55 Aperture holder

Experiment lamp, student

The Experiment Lamp is designed to use a standard E10 6 V, 1 A incandescent lamp. Well-suited for experiments in optics using the optical table, item no. 2915.00 (see page 68). The 30 mm diameter black anodized lamp housing has a removable rear plate with an E10 lamp housing and safety jack receptacles for connecting standard leads with 4 mm jacks. Supplied with 10 mm diameter mounting tap and 1 ea. 6 V, 1 A incandescent lamp (item no. 4250.40). Height: 110 mm. Mass: 86 g.

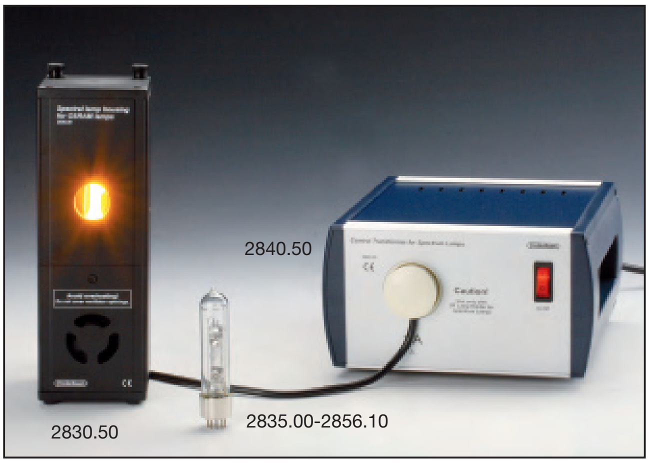
2800.20 Experiment lamp, student, without stand

Control Transformer for Spectrum Lamps
CE
Caution!
1 A

Spectral lamps, Osram

A powerful light source for producing line spectra or monochromatic light when used with the appropriate filters.
Lamps with 9 pole Pico sockets with external gas glow head for visible spectral emission.
Length: 100 mm. Diameter: 20 mm.
For mounting inside spectral lamp housing no. 2830.50.

2835.00 Spectral lamp Na-10
2835.20 Spectral lamp Cd-10
2835.30 Spectral lamp He-10
2835.40 Spectral lamp Ne-10
2835.50 Spectral lamp Zn-10
2836.10 Spectral lamp Hg-100



Control transformer

Used in conjunction with Osram spectral lamps. 3-pin socket for connection of lamp holder. Max. 1 A.
Dimensions: Width 185, height 120, depth 220 mm.
Power supply: 220 VAC.

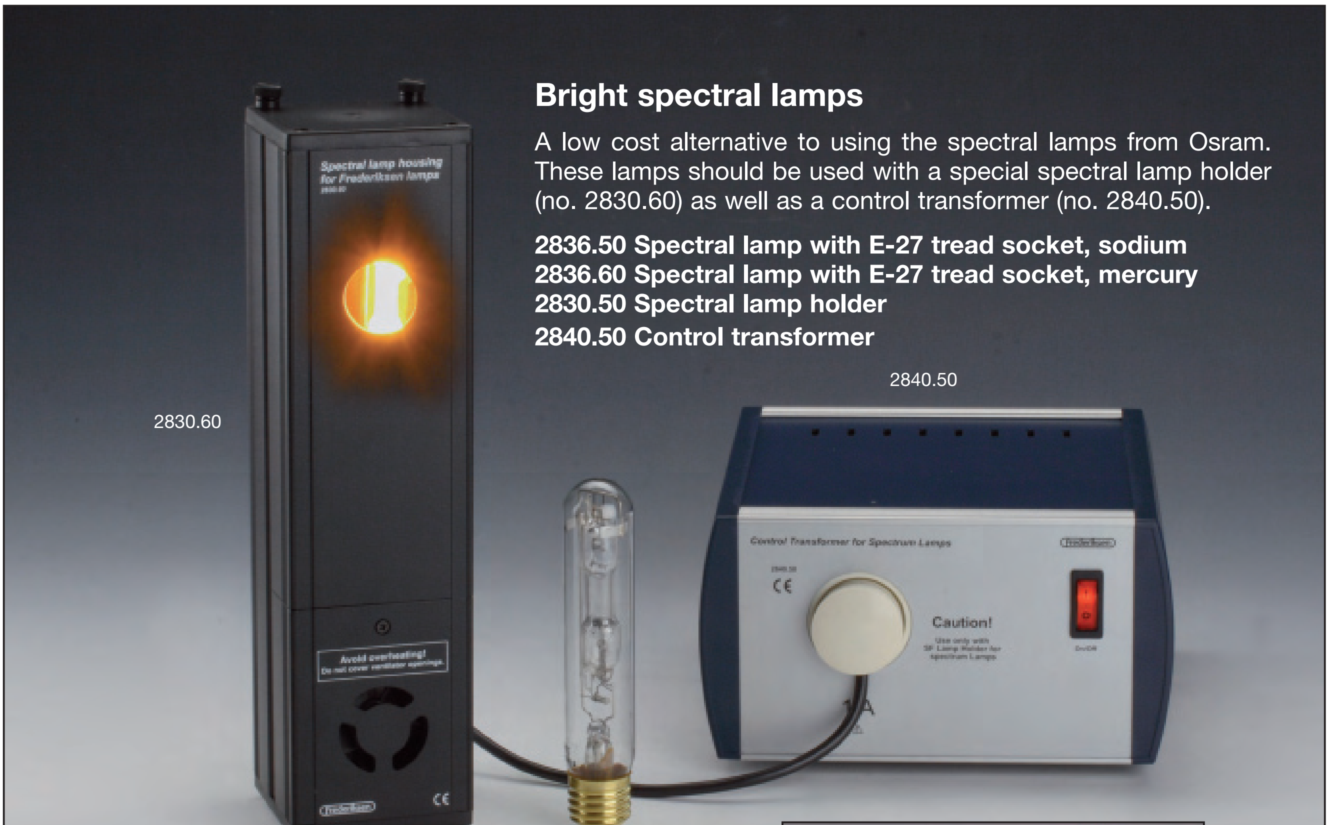
2840.50 Control transformer

Lamp holder for spectral lamps

The well known Lamp Holder for Osram spectral lamps no. 2835.00-2835.50 and 2836.10 in a new design, with cooling fan to assure that the surface of the Lamp Holder remains below 50 °C. Equipped with 3-pin plug for control transformer no. 2840.50. Provided with 10 mm diameter support rod.
Dimensions: 78 x 78 x 236 mm.

2830.50 Lamp holder for spectral lamps

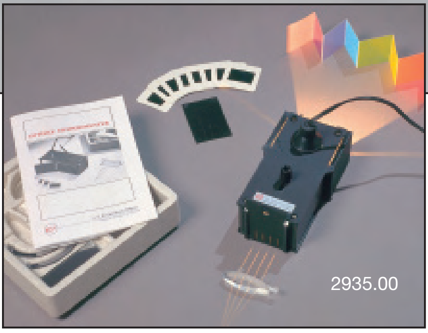
2830.50
Spectral lamp housing for OSRAM lamps
Avoid overheating!



Bright spectral lamps

A low cost alternative to using the spectral lamps from Osram. These lamps should be used with a special spectral lamp holder (no. 2830.60) as well as a control transformer (no. 2840.50).

2836.50 Spectral lamp with E-27 tread socket, sodium
2836.60 Spectral lamp with E-27 tread socket, mercury
2830.50 Spectral lamp holder
2840.50 Control transformer



Optical set with lightbox excl. manual

Very comprehensive set for teaching geometrical optics and mixing of colours.
The set is consisting of a light box with a 12V halogen bulb, different lenses, slits, colour filters and mirrors. Al together 24 parts.

2935.00 Optical set with lightbox excl. manual

Spectral tube holder and power supply

This holder makes the use of spectral tubes easier and safer. The spectral tube is mounted from the front in the insulated holders with electrodes, where the lower holder is spring loaded parallel to the tube axis.
The holder is provided with a power supply which can deliver 6 kVDC at max. 2 mA to the electrodes built into the base of the insulated holder.
Can be used with spectral tubes 2850.00 – 2851.30 and with many other types of spectral tubes.
Dimensions: 78 x 78 x 290 mm. For 220 V AC.

2855.50 Spectral tube holder and power supply

Spectral tubes

Straight pattern, capillary length approximately 70 mm. Fitted with a 6.5 mm diameter contact caps at each end. For observing line and band spectra from various nobel and diatomic gasses.

For mounting inside spectral tube holder 2855.50 page 67.

2850.00 Spectral tube Ne
2850.10 Spectral tube Hg
2850.20 Spectral tube H_2
2850.30 Spectral tube He
2850.40 Spectral tube Ar
2850.50 Spectral tube O_2
2850.60 Spectral tube Kr
2850.70 Spectral tube N_2
2851.10 Spectral tube H_2O
2851.20 Spectral tube CO_2
2851.30 Spectral tube Xe

2850.00-.70
2851.10-.30

Halogen lamp, 150 W

Suitable for solar cell experiments. For 220V AC. Supplied with steel rod.

2801.00 Halogen lamp

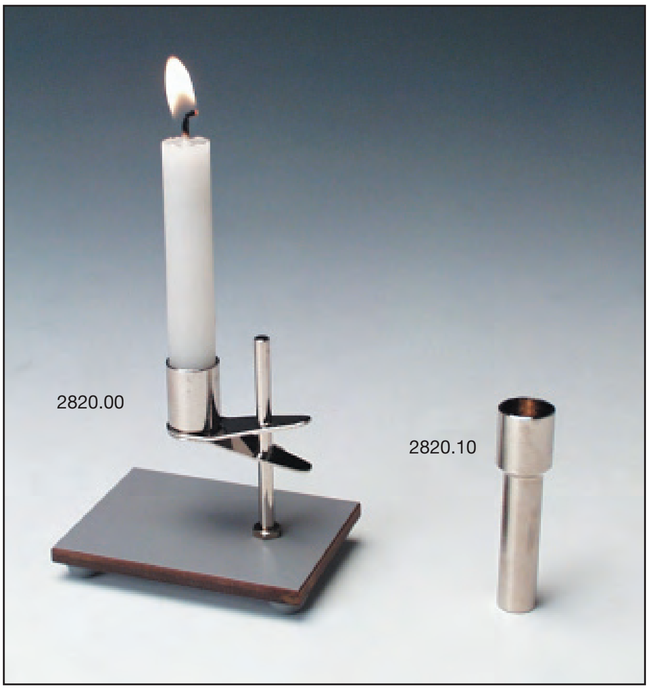
2801.00

Ultra-Violet Lamp
UVA 315 - 400 nm
2871.00
CE
2871.00

UVA lamp

This UVA lamp emits both spectral light (4 lines from the mercury spectrum) and a band of UV light in the range from 350 nm to 400 nm.
The UV lamp is supplied with an ordinary power plug (for direct connection to mains power).
Dimensions: 190 x 75 x 75 mm.

2871.00 UVA lamp



Candle holder on support stand

This candle holder is useful in experiments with image formation using convex lenses. The stand is supplied with a moveable candle holder so that the candle can be placed at just the right height.
Height: 65 mm.
Mass: 50 g.

2820.00 Candle holder on support stand

Candle holder

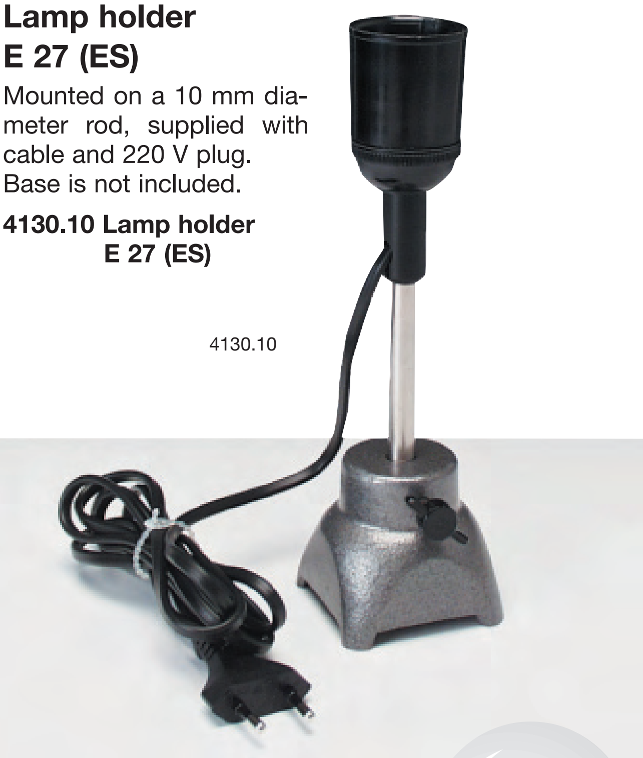
This holder is designed for candles (item no. 2810.00). The holder is supplied with a 10 mm diameter rod which fits standard laboratory support hardware.
Height: 55 mm. Mass: 30 g.

2820.10 Candle holder

Lamp holder E 27 (ES)

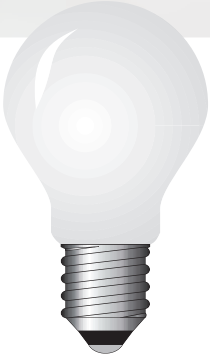
Mounted on a 10 mm diameter rod, supplied with cable and 220 V plug.
Base is not included.

4130.10 Lamp holder E 27 (ES)



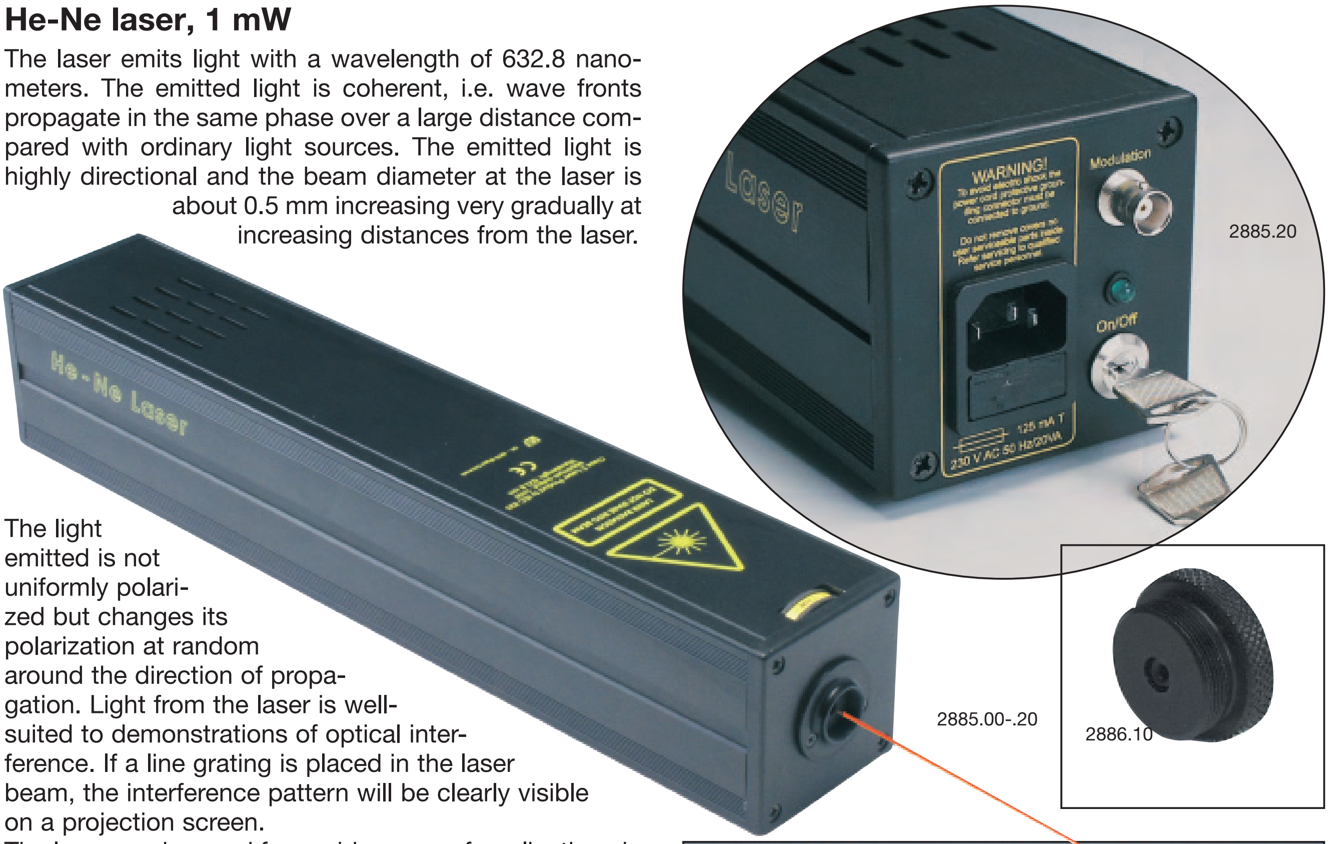
Incandescent lamp with Edison socket

4260.10	220 V	15 W	E27 mat
4260.20	220 V	40 W	E27 mat
4260.30	220 V	60 W	E27 mat
4260.40	220 V	100 W	E27 mat
4260.50	220 V	150 W	E27 mat
4261.10	220 V	25 W	E27 mat



He-Ne laser, 1 mW

The laser emits light with a wavelength of 632.8 nanometers. The emitted light is coherent, i.e. wave fronts propagate in the same phase over a large distance compared with ordinary light sources. The emitted light is highly directional and the beam diameter at the laser is about 0.5 mm increasing very gradually at increasing distances from the laser.



The light emitted is not uniformly polarized but changes its polarization at random around the direction of propagation. Light from the laser is well-suited to demonstrations of optical interference. If a line grating is placed in the laser beam, the interference pattern will be clearly visible on a projection screen.
The laser can be used for a wide range of applications in geometrical optics, holography, communication etc.

2885.00 He-Ne laser, 1 mW

2885.10 He-Ne laser, 2 mW

He-Ne laser, modulated, 1 mW

Laser like the 2885.00 but with the option of modulating the light beam. The laser is provided with a BNC-connector for connection to a signal generator, CD-player or similar signal source. The light beam intensity will then vary with the applied signal. Well suited for demonstration of optical communication using photodetector no. 4895.50, see page 69. Maximum modulation frequency: 1 MHz.

2885.20 Modulated laser

Optical fiber holder

This threaded adapter has a centering hole and is designed for optical fiber item no. 2887.00. The cable is secured and centered by means of an O-ring.

2886.10 Optical fiber holder

Optical fiber

This flexible optical fiber guides light rays along circular paths from one place to another. It can be readily cut to the desired length by means of a sharp cutting instrument. It can be used in electronics, models, data transfer projects, etc. The external diameter of the fiber with protective covering is 2.2 mm, while the optical fiber itself is 1 mm in diameter.

2887.00 Optical fiber, per meter

2887.00
0785.64

Laser objective

This convex lens is used to spread light from a laser. It is useful when producing holograms or in other optical experiments where a broad illumination field is desired. The objective is supplied with a threaded adapter for mounting to the laser's optics adapter.

0785.64 Laser objective x40
0775.28 Laser objective x60

Laser pointer

Easy to use pencil sized diode laser pointer. Run on batteries. Works well when experimenting with refraction of light in various materials.
Wavelength: 670 nm
Power: < 1 mW (class II)
Beamdivergence v/22m: Diameter < 27 mm.

1420.70 Laser pointer

Photo detector

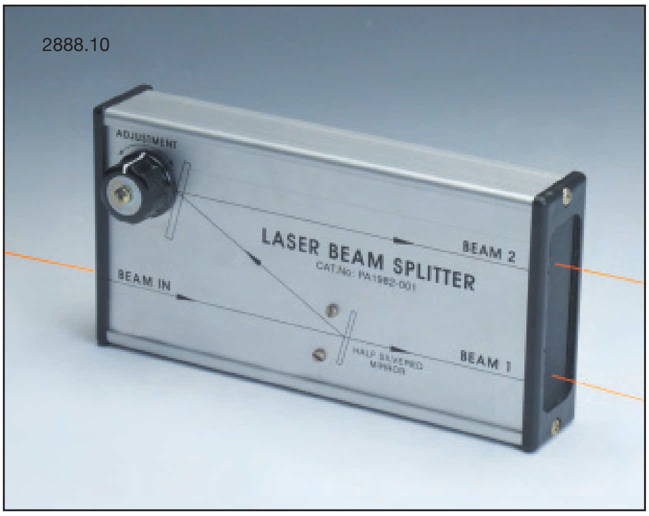
This photo detector is equipped with a photo gate that transforms the laser beam to electric current that can be used to power the built in speaker and measured at the analog or digital output bushing. The photo detector can be used for demonstrating communication by laser or fiber optics, or demonstration of interference. Max frequency 1 MHz.

4895.50 Photo detector

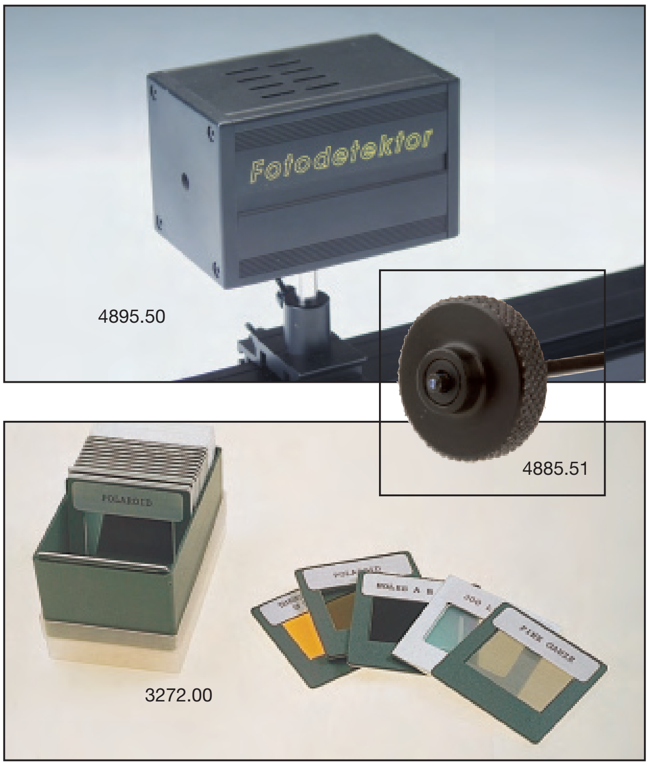
Holder for optical fiber for photo detector

Fits the photo detector 4885.50. For adding optical fibre 2887.00

4885.51 Holder for optical fiber for photo detector



4895.50
Fotodetektor



Laser diffraction kit

This kit comprises 18 slides which allow performance and demonstration of e.g. “Fraunhofer Diffraction”, “Fresnel Diffraction”, a number of other diffraction experiments, to explore the topic of holograms and many other experiments. The slides are labelled and comes in a storage box complete with an inventory list and brief experiment notes.

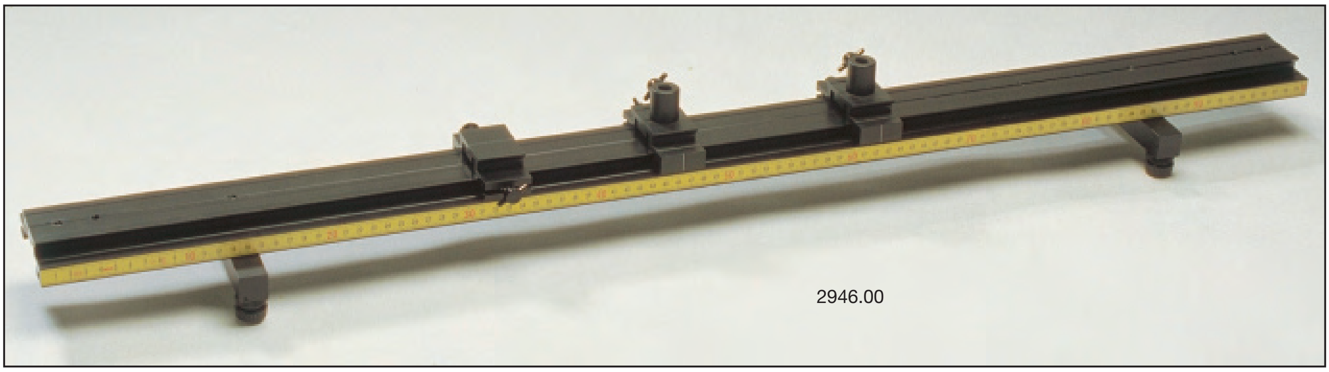
3272.00 Laser Diffraction Kit

Beam splitter

A semitransparent mirror is mounted in a robust housing. The reflected laser beam strikes an adjustable mirror so that the device can produce two parallel laser beams. This can be used to compare two optical paths, e.g. in connection with experiments with the speed of light.

2888.10 Beam splitter

Optical bench



Optical bench

A stable optical bench, offering a convenient way of carrying out optical experiments as well as different experiments with radioactive sources (e.g. no. 5100.00).
The bench is made of black-anodized aluminium and equipped with ruler on the side.
Supplied with the following standard equipment: 2 sliding saddles (no. 2946.20) with 10 mm diameter hole for fixing various equipment.
1 sliding saddle (no. 2946.20) for optical disc and 10 mm diameter hole. 2 feet with rubber pads and levelling screws (no. 2946.30).
Total length 100 cm. Cross section 26 x 82 mm.

2946.00 Optical bench

Sliding saddle

For optical bench 2946.00. For fixing of optical equipment with max. 10 mm diameter fixing rod.
Dimensions: 35 x 50 x 84 mm. Made of black-anodized aluminium with thumb screw and measuring line.

2946.10 Sliding saddle

Sliding saddle

As no. 2946.00, however, with slits for optical disc.

2946.20 Sliding saddle

Base for optical bench

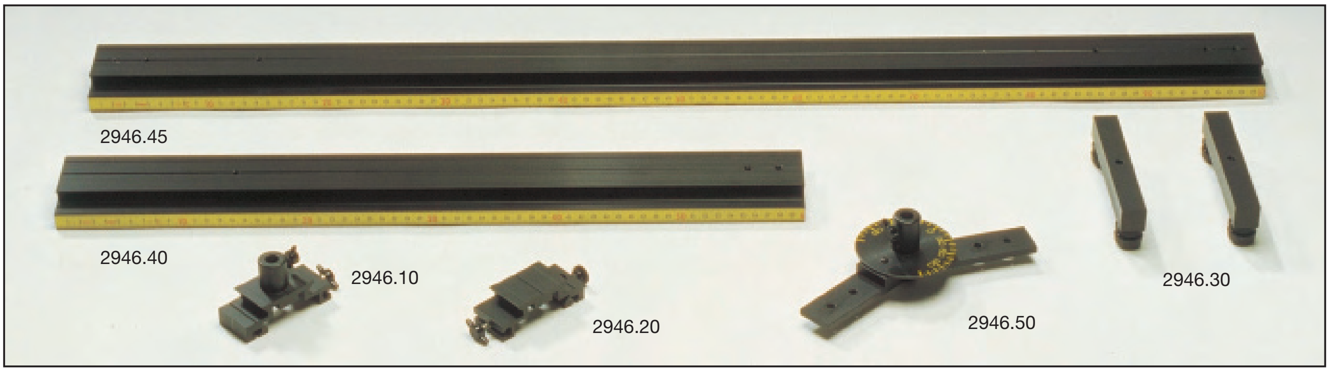
Base with rubber pads and two levelling screws, in black anodized aluminium.
Dimensions: Length: 125 mm, Height: 50 mm, Width: 25 mm.

2946.30 Base for optical bench

Extension section for optical bench

Black-anodized extension section for the optical bench no. 2946.00. Equipped with a ruler. Length: 600 mm.

2946.40 Extension section for optical bench



Extension section for optical bench 1000 mm

Like 2946.40 but length 1000 mm. Weight 2.2 kg.

2946.45 Extension section for optical bench 1000 mm

Extension section for optical bench 2000 mm

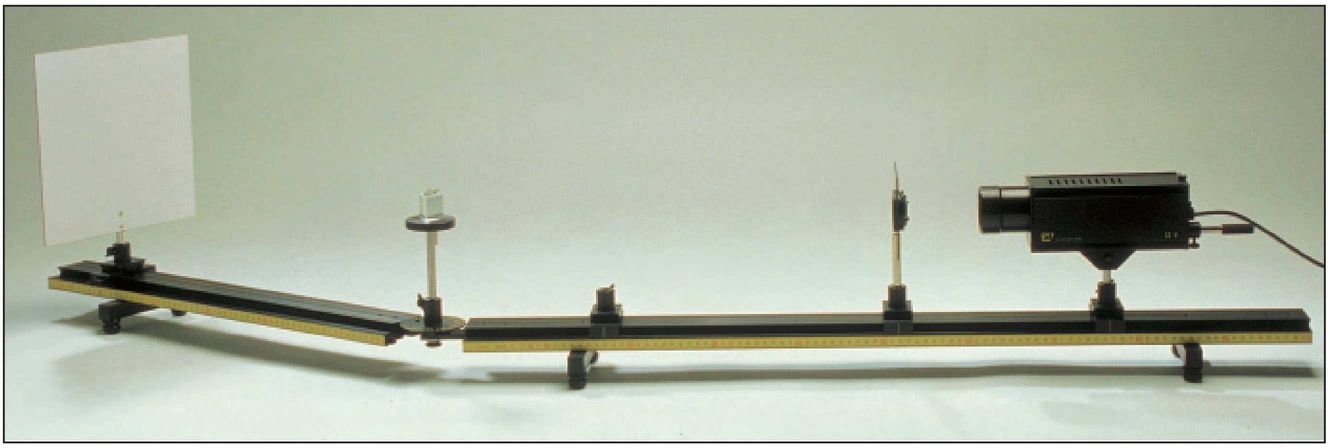
Like 2946.40 but length 2000 mm. Weight 4.4 kg.

2946.46 Extension section for optical bench 2000 mm

Joint Link for optical bench

Joint link in black-anodized aluminium with graduation for coupling of the optical bench to the extension section.

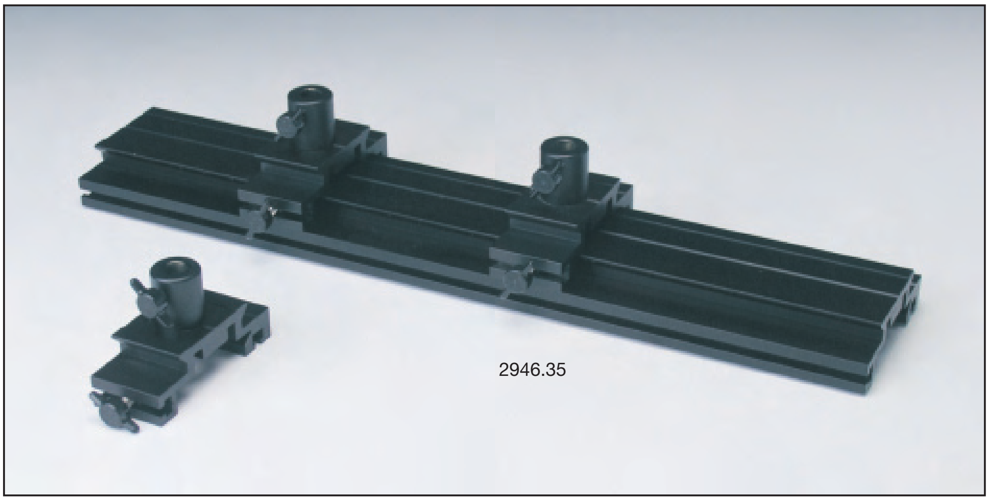
2946.50 Joint link for optical bench



Profiled rail w/o sliding saddle

Profiled rail designed for mounting and aligning equipment relative to each other. To be used with one or more sliding saddles (no. 2946.00) with 10 mm diameter hole and thumb screws. Length: 370 mm.

2946.35 Profiled rail w/o sliding saddle



Lenses, prisms and diaphragms

Lenses in holder

For use in conjunction with the optical bench. Lens diameter 50 mm. Mounted in rectangular plastic plate 100 x 100 mm with 10 mm fixing rod and printed focal distance.

2950.10 Lens in holder, + 300 mm
2950.20 Lens in holder, + 100 mm
2950.30 Lens in holder, + 50 mm
2950.40 Lens in holder, - 200 mm

Lens and slide holder

A versatile holder made to fix slides max. 50 x 50 mm and lenses 50 mm diameter. 2 spring loaded clips allows you to fix slides and lenses of max. 16 mm thickness. Supplied with a 10 mm diameter steel rod for fixing in an optical bench etc. Overall length 170 mm. Net weight: 130 g.

2902.01 Lens and slide holder

+30
+10
+5
2950.10-.40
-20
5760.40

Set of lenses 50 mm diameter

The set of lenses comprises 6 different lenses Ø 50 mm. The lenses can be mounted in the Lens and Slide Holder no. 2902.01. The set of lenses may be used for a number of optics experiment but are also specified to be particularly well suited for laser experiments. The lenses comes complete in a storage box and are specified as follows:

1 ea. Biconcave	50 mm dia., focal length	100 mm
1 ea. Biconcave	50 mm dia., focal length	50 mm
1 ea. Biconvex	50 mm dia., focal length	50 mm
1 ea. Biconvex	50 mm dia., focal length	100 mm
1 ea. Biconvex	50 mm dia., focal length	200 mm
1 ea. Biconvex	50 mm dia., focal length	1000 mm

2903.00 Set of lenses 50 mm, diameter

2902.01
2903.00

Iris diaphragm

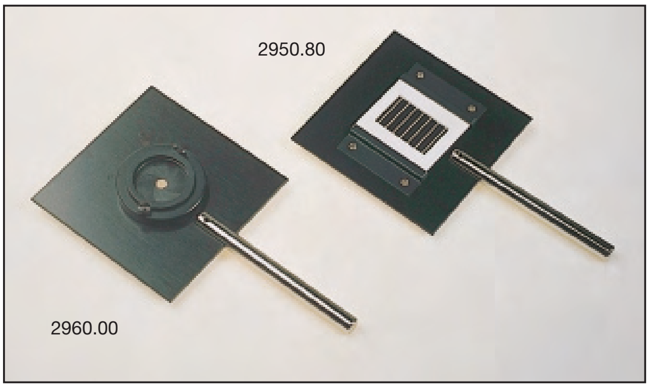
Black plastic screen 100 x 100 mm with 10 mm diameter fixing rod. Maximum aperture 28 mm diameter.

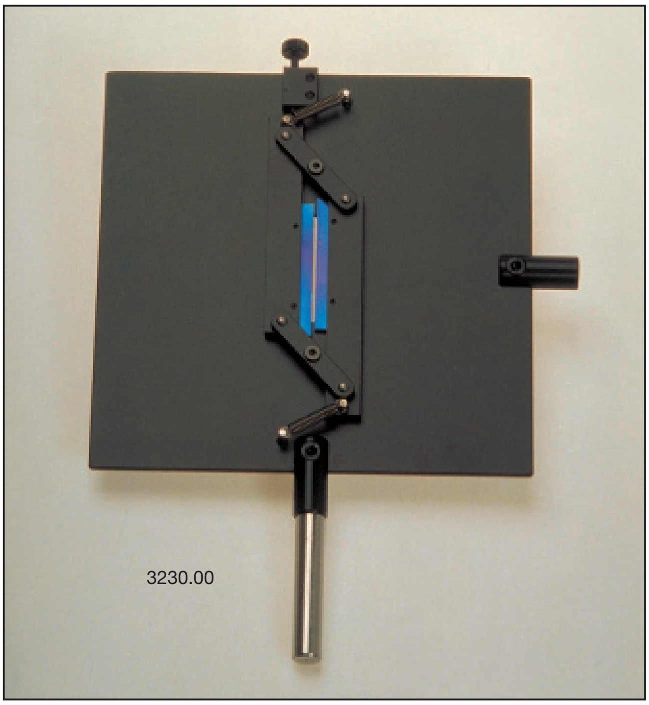
2960.00 Iris diaphragm

Slits and filter holder

Designed to accept slits and filters etc. 50 mm square by a maximum of 3.5 mm thickness, 100 x 100 mm. Plastic guard with 10 mm diameter fixing rod.

2950.80 Slits and filter holder





Adjustable slit

Slit length 42 mm, width continously adjustable to a maximum of approximately 9 mm by means of a spring loaded knurled knob. Made of black-coloured brass, placed in a black-anodized aluminium square, 150 mm side length with 10 mm stem. The adjustable slit can be positioned vertically or horizontally.

3230.00 Adjustable slit

Ground glass screen

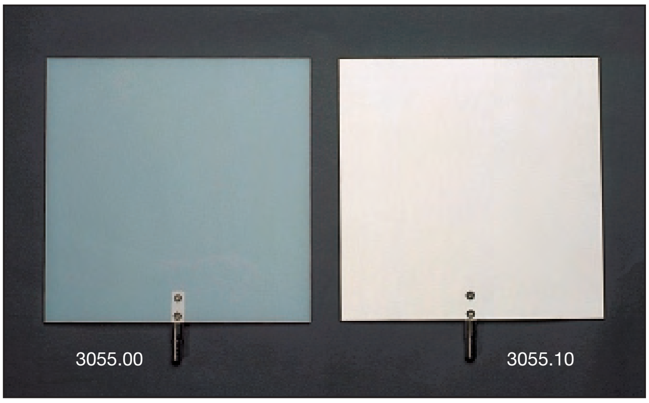
Made of plexiglass. Dimensions: Height 250 mm, width 250 mm, with 10 mm fixing rod.

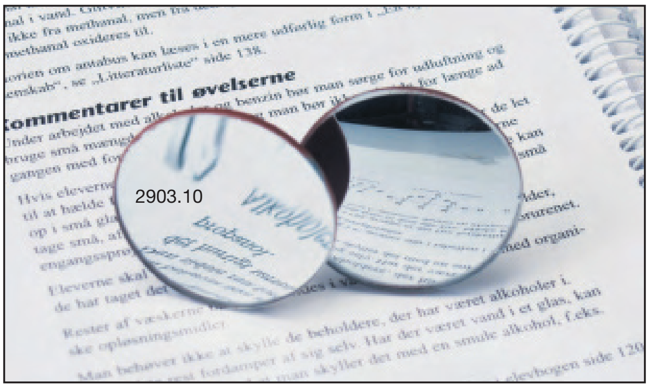
3055.00 Ground glass screen

White screen

In laminated plastic with white surface. Dimensions: Height 250 mm, width 250 mm, with 10 mm fixing rod.

3055.10 White screen





Set of mirrors, convex/concave

Two mirrors, one concave and one convex. Fits holder 2902.01. Diameter 50 mm, focal length +/- 100 mm.

2903.10 Set of Mirrors, convex/concave

Prism table

Circular, diameter 62 mm mounted on 10 mm diameter stem. With adjustable springloaded clamp to accommodate prisms from 10 to 50 mm high.

2990.00 Prism table

Optical disc

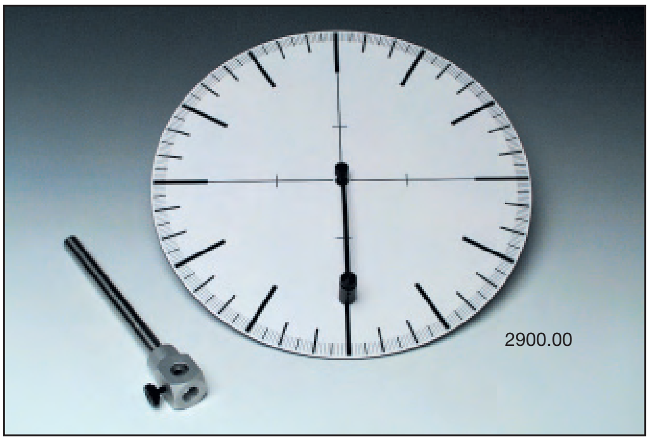
A 250 mm diameter white faced disc clearly marked at every 5° and with crosshairs at 90° to mark the centre. Supplied with 10 mm diameter rod, allowing the disc to be rotated round the center. The optical disc is equipped with a holder for plastic blocks.

2900.00 Optical disc

Optics kit

A complete set of acrylic prism/blocks and mirrors suitable for doing all of the classical optics experiments. Supplied complete in a partitioned storage box, which solves two major problems with one blow. It is always easy to check if the set is complete, and delicate lenses and mirrors are not scratched or dented. All the acrylic blocks are made of clear polished acrylic resin free from striae and bubbles. Bottom surface finished in white to show ray tracks, 19 mm thick. The kit comprises the following items which may also be supplied separately: 2905.00/20/30/40/50/60 and the mirrors no. 2908.00 and 2910.00.

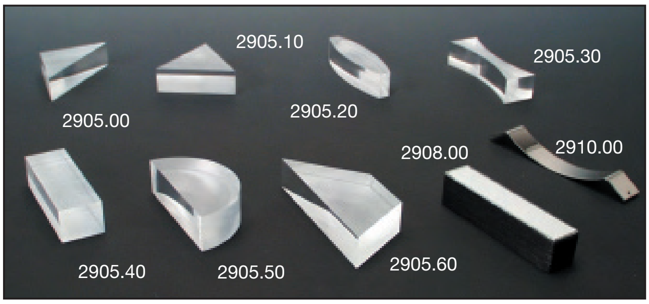
2902.00 Optics kit

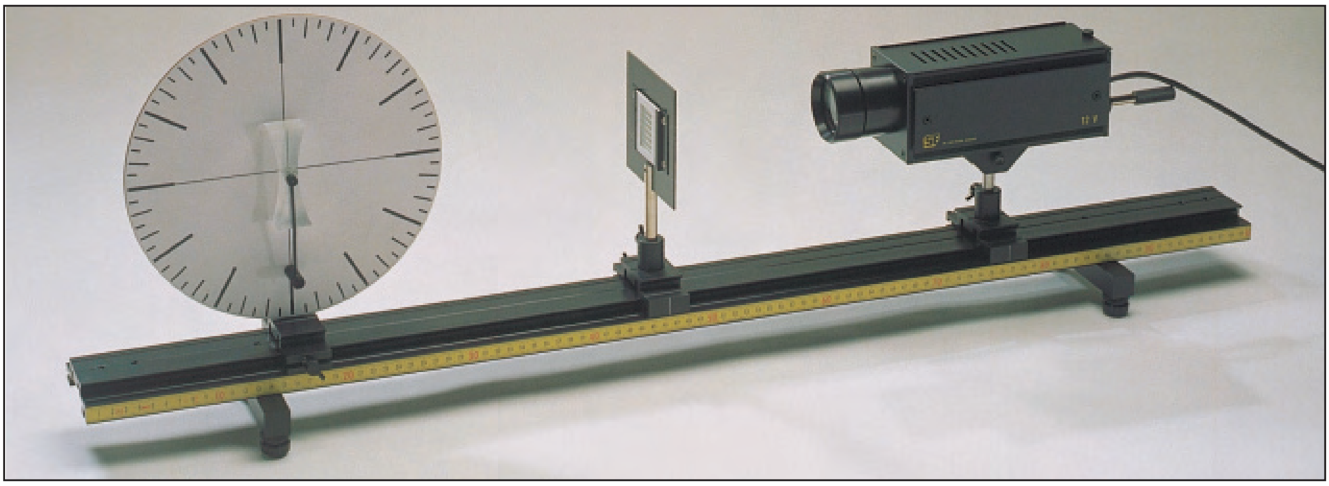


Acrylic plastic blocks

For refraction experiments. Clear, polished blocks, free from striae and bubbles. Bottom surface finished in white to show ray tracks. 19 mm thick.

No.	Type	Dimension
2905.00	Triangular block	90°, 45°, 80 x 56 mm.
2905.10	Triangular block	Equilateral, side 64 mm.
2905.20	Biconvex block	79 mm, radius 205 mm.
2905.30	Biconcave block	79 mm, radius 205 mm.
2905.40	Rectangular block	Side 75 x 25mm.
2905.50	Semicircular block	80 mm diameter.
2905.60	Trapezoidal prism.	Total Length: 100 mm
2908.00	Plane mirror	Glass, back-silvered, mounted on a hardwood cube. Side length 90 mm.
2910.00	Cylindrical mirror	Made of nickel-plated brass. Side length 110 mm.

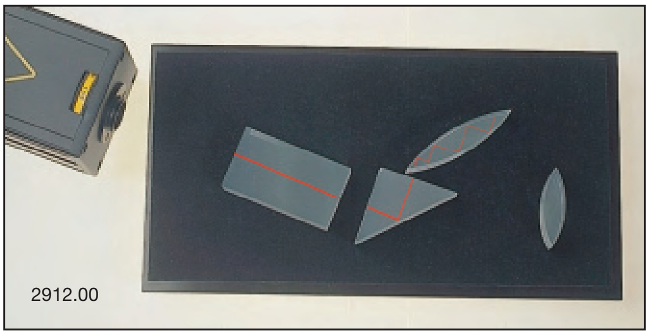




Smoke lenses, set of 4

Optics experiments will never be the same without smoked lenses once you have tried them. Students can see the light as it passes through the lenses. Refraction and internal reflection are observed with a clarity never seen before. Especially well suited for experiments with lasers. The set comprises 4 lenses 20 mm thick made of a special acrylic resin: 2 convex lenses 50 and 100 mm focal length, 1 prism 90°, 45°, 45° and 1 ea. rectangular block.

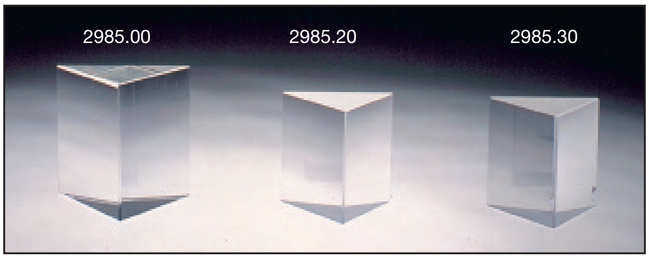
2912.00 Smoked lenses, set of 4



Prism, equilateral

Made of glass with polished faces. Triangle side 34 mm, height 35 mm.

2985.00 Prism, equilateral



Newton's prism

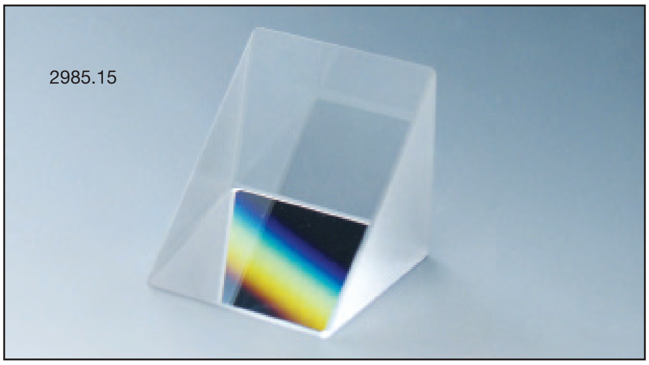
As item 2985.00 but with triangle side length 34 mm and height 25 mm.

2985.10 Newton's prism

Glass Prism, right angle

Side lengths: 40 mm and 54 mm, height: 40 mm.

2985.15 Glass prism, right angle



Crown prism

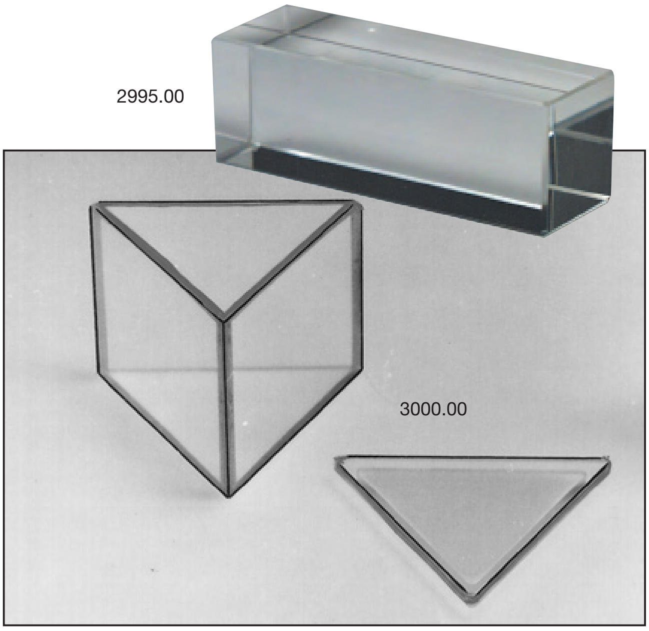
Triangle side 30 mm, height 30 mm.

2985.20 Crown prism

Flint prism

Triangle side 30 mm, height 30 mm.

2985.30 Flint prism



Prism four-sided

Four-sided prism with polished surface for experimenting with path of rays in plan parallel objects. Dimension: 60 x 20 x 20 mm.

2995.00 Prism four-sided

Prism, hollow 60°

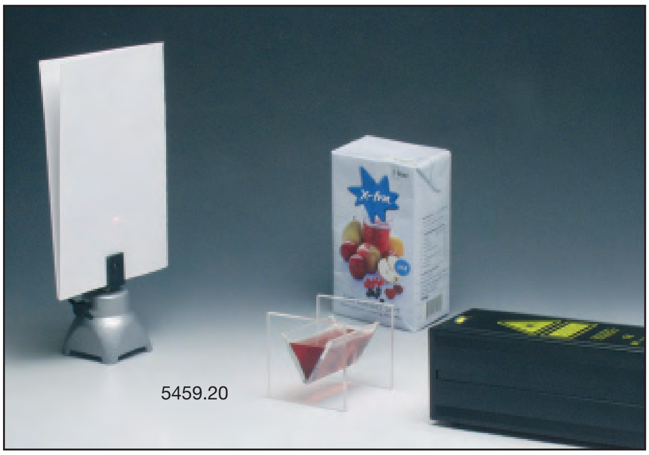
Hollow prism with 3 mm glass lenses and detachable top. Outer length 68 mm. Height 53 mm. For demonstrating refraction in liquids.

3000.00 Prism, hollow 60°

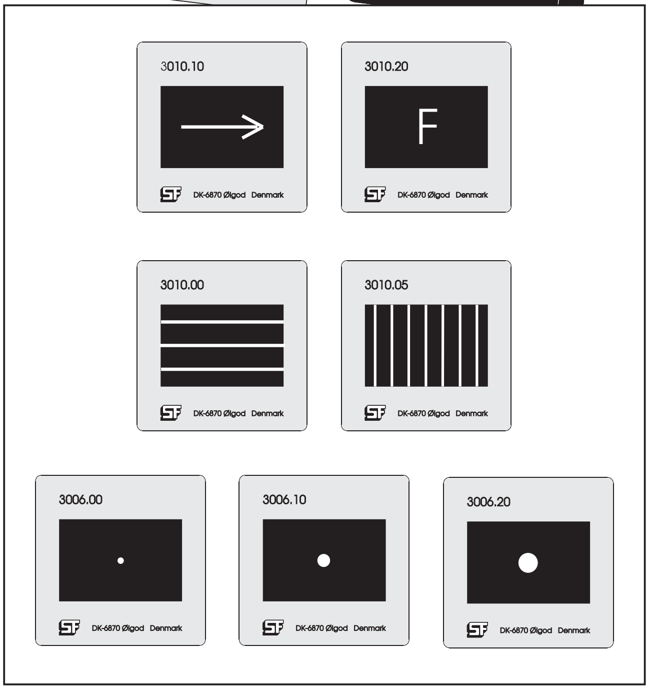
Sugar prism

This simple apparatus provides a simple method for computing the sugar concentration in liquids, e.g. soda pop. Using a number of reference solutions with known sugar content one can compare the refraction of light, e.g. a laser beam, of reference samples and an unknown solution. Supplied with complete instructions for student projects and experiments.

5459.20 Sugar prism



3240.10
DK-6870 Ølgod Denmark



Frosted Glass

Frosted glass, 50 x 50 mm, fits standard slit support. Well suited to optics experiments.

3010.50 Frosted glass

Apertures slits and gratings

Single slit

Slit width 1.5 mm. The slit is shaped like an arrow.

3010.10 Single slit

Triple slit

Spacing between slits 7 mm, slit width 1 mm.

3010.00 Triple slit

Double slit

Mounted in a dias frame between two glass plates. Dimensions 50 x 50 mm. Spacing between slits 0.1 mm.

3240.10 Double slit

Single slits, various widths

This aperture consists of five different slit widths for demonstrations of diffraction patterns. Size: 50 x 50 mm.

3230.10 Single slits, various widths

Seven slits

spacing between slits 5 mm, slit width 0,8 mm.

3010.05 Seven slit

“F” slit

Slit width 1 mm. Used as aperture for the at picture demonstration, where it can be seen whether or not the picture is inverted.

3010.20 “F” slit

Slides with aperture

3006.00 Slide, 1 mm diameter aperture

3006.10 Slide, 2 mm diameter aperture

3006.20 Slide, 4 mm diameter aperture

Mirrors

Plane mirror

Glass, back-silvered with protective coating. Rectangular 180 x 120 mm.

3040.20 Plane mirror

Mirrors, flat plastic

This mirrored plastic plate is shatterproof, and it can be cut with a scissors. It is mirrored on both sides. Size: 90 x 65 x 1.2 mm. Package of 8 ea.

3066.00 Mirror, flat, 8 ea.

Mirrors, concave/convex, plastic

These mirrored plastic plastes are 100 x 100 x 1.5 mm. They are mirrored on both sides and shaped like a convex mirror. Package of 10 ea.

3066.10 Mirrors, concave/convex, plastic

Mirror, concave and convex

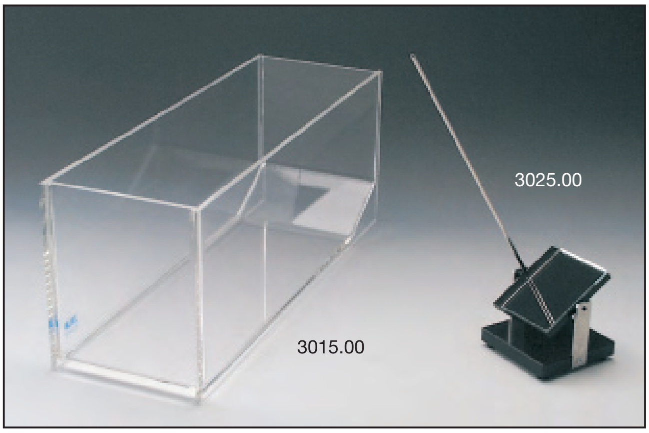
Mounted back-silvered spherical mirrors 115 mm diameter 190 mm focal length, mounted back to back in a metal frame.
The frame is mounted on a 10 mm rod, length 100 mm.

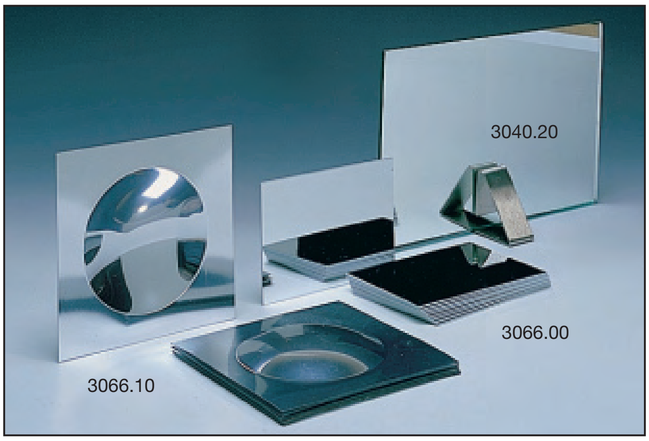
3065.00 Mirror, concave and convex

Mirror, rotatable with indicator needle

This rotatable mirror is mounted on a stand. It is used e.g. in a refraction vat for observing angles of incidence and reflection in water containing fluorescein dye.

3025.00 Mirror, rotatable with indicator needle





3070.00
2055.00

Mirror, rotating

This is used for experiments with light requiring a rotating mirror. There are mirrors on all four sides. The mirror area is 90 x 117 mm. Supplied with a 10 mm diameter mounting rod. Supplied without rotating bearing (item no. 2055.00).

3070.00 Mirror, rotating

Light refraction vat

Plexiglas vat. This vat is supplied with plane parallel sides. It is ideal for optical experiments.
Size: 370 x 130 x 150 mm.

3015.00 Light refraction vat

Sodium fluorescein

This fluoresceint colored powder is added to water to emphasize the optical path of e.g. a laser beam. It can be supplied either as a powder or in solution. The prices indicated are less weighing and packaging.

8298.00 Sodium fluorescein, powder
8299.00 Sodium fluorescein, solution 0.4%

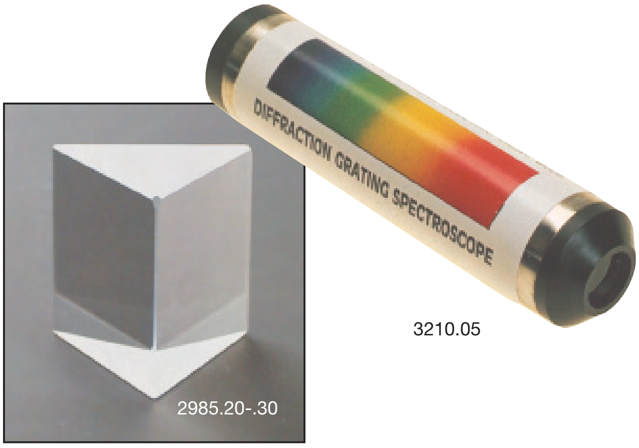
Spectroscopy

Prisms (equilateral)

High quality prisms suited for spectrometer no. 3215.30 to measure spectral lines as well as to determine refracte indices of prisms.
Dimensions: side length 30 mm, height 30 mm

2985.20 Crown glass prism

2985.30 Flint prism



3210.05

2985.20-.30

Hand spectroscope, direct viewing

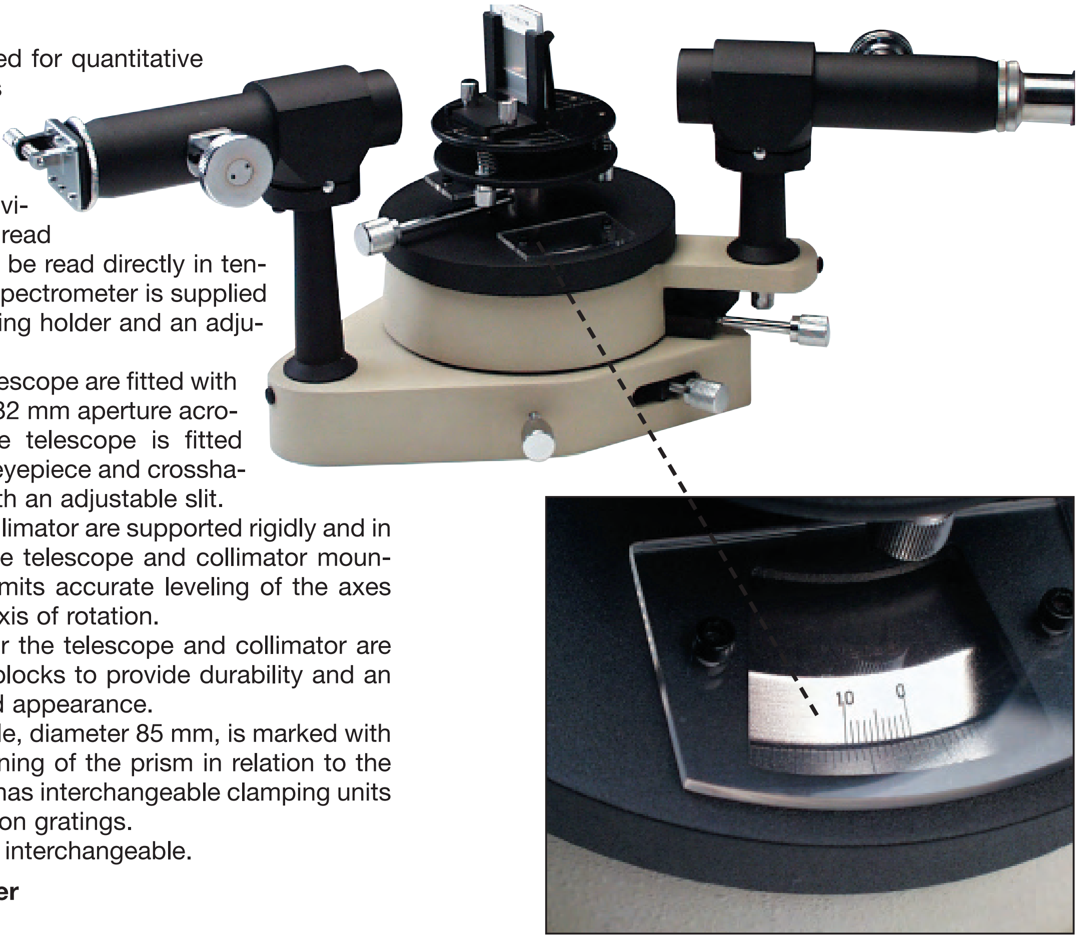
Hand spectroscope designed for class room use. This usefull instrument gives an excellent band width of spectra by using 600 lines per mm. Prismatic optical system for diverging image correcting. Overall dimensions: Diameter 25 mm, length 105 mm.

3210.05 Hand spectroscope, direct viewing

Spectrometer

This instrument is used for quantitative light experiments where refraction and diffraction of light is investigated. The instrument is provided with an easy to read vernier scale that can be read directly in tenths of a degree. The spectrometer is supplied with a prism and grating holder and an adjustable prism table.
The collimator and telescope are fitted with 178 mm focal length 32 mm aperture acromatic objectives. The telescope is fitted with a 15x Ramsden eyepiece and crosshair reticle collimator with an adjustable slit.
The telescope and collimator are supported rigidly and in perfect alignment. The telescope and collimator mounting arrangement permits accurate leveling of the axes and squaring to the axis of rotation.
The support pillars for the telescope and collimator are made of solid metal blocks to provide durability and an enhanced streamlined appearance.
The spectrometer table, diameter 85 mm, is marked with lines to assist positioning of the prism in relation to the leveling screw, and it has interchangeable clamping units for prism and diffraction gratings.
All essential parts are interchangeable.

3215.30 Spectrometer



REQUIRED ACCESSORIES

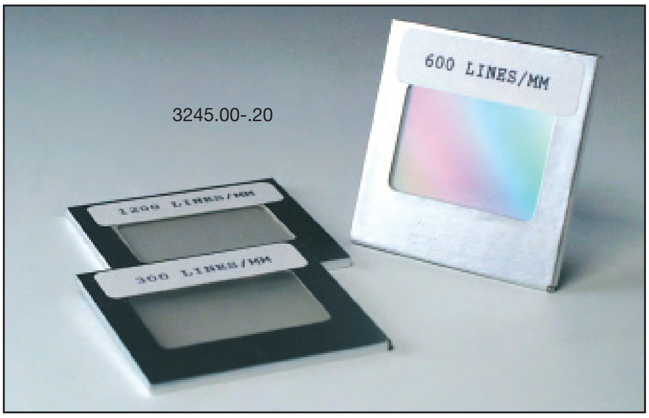
2830.50	Spectral lamp housing
2835.00-2836.10	Spectral lamps
2840.50	Ballast transformer
3255.05-3255.10	Optical grating
2985.30	Flint glass prism

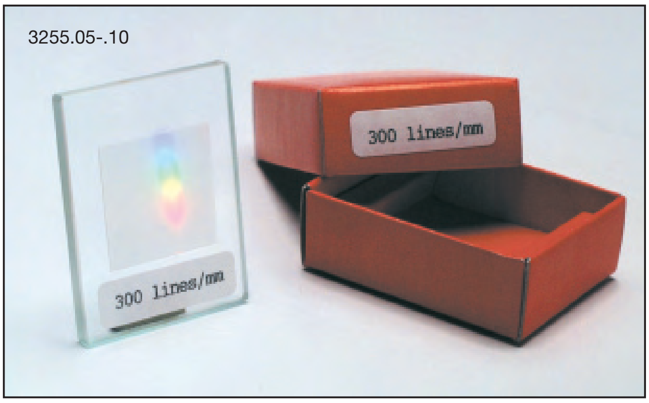
Diffraction gratings

Optical gratings, 24 x 36 mm

A replicate grating mounted between two plane parallel plates of glass. Frame area: 50 x 50 mm.
Grating area: 24 x 36 mm.

3245.00 Optical grating, 300 lines/mm
3245.10 Optical grating, 600 lines/mm
3245.20 Optical grating, 1200 lines/m


3245.00-.20
600 LINES/MM
1200 LINES/MM
300 LINES/MM


3255.05-.10
300 lines/mm
300 lines/mm

3260.00
EDUCATIONAL DIFFRACTION GRATING
100 lines/mm
300 lines/mm
600 lines/mm

Diffraction grating

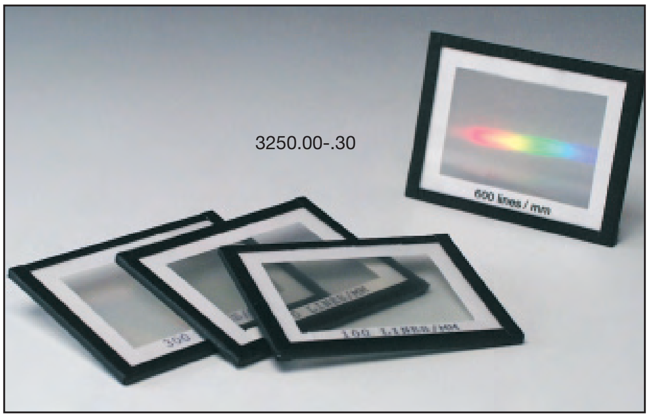
A demonstration slide consisting of three gratings with grating constants of 100, 300 and 600 lines/mm respectively. Each has an area of 9 x 16 mm. They are mounted between plane parallel glass plates in a cardboard slide 90 x 30 mm in size.

3260.00 Diffraction grating

Optical gratings, 30 x 45 mm

A replicate grating mounted between two plane parallel glass plates. Frame area: 48 x 63.5 mm.
Grating area: 30 x 45 mm.

3250.00 Optical grating, 100 lines/mm
3250.10 Optical grating, 200 lines/mm
3250.20 Optical grating, 300 lines/mm
3250.30 Optical grating, 600 lines/mm

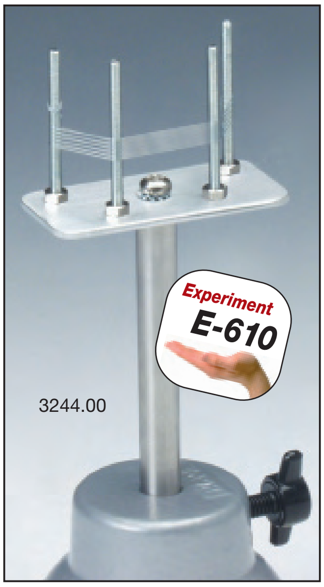

3250.00-.30
600 lines/mm
300
100 LINES/MM

Diffraction grating (Rowland)

Diffraction grating glass copy on glass carrier, grating surface approx. 25 x 25 mm. Carrier surface 38 x 50 mm, thickness 4 mm, suited for spectrometer no. 3215.30

3255.05 Diffraction grating 300 lines/mm
3255.10 Diffraction grating 600 lines/mm

Grating model


Experiment
E-610
3244.00

It can sometimes be difficult for students to visualize the optical diffraction grating. Standard gratings have very small gratings constants, so the line spacing can not be seen. Acoustic analogies are difficult to set up and also challenge student understanding. Using machine screws with a well-defined pitch and 0.30 mm nylon line it is possible to produce your own simple optical grating. Using a laser beam and at a distance of 6 to 10 meters from the grating to a projection screen it is possible to clearly see the diffraction pattern caused by this large spacing grating. This device provides students with a clearly visible example of an operating optical grating.

3244.00 Grating model

Colours

Color filters, foil

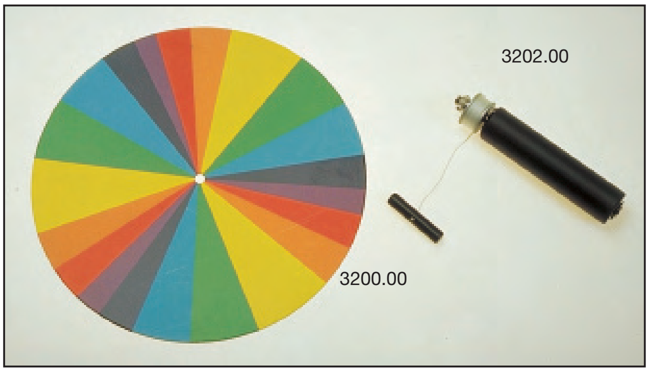
These transparent colored foils are supplied in rolls 50 x 122 cm. These color filters are reasonably selective and correct compared with the international color standards. The filters can be cut into A4 format or other appropriate sizes for use on overhead projectors or e.g. 6 x 6 cm sizes for student use.

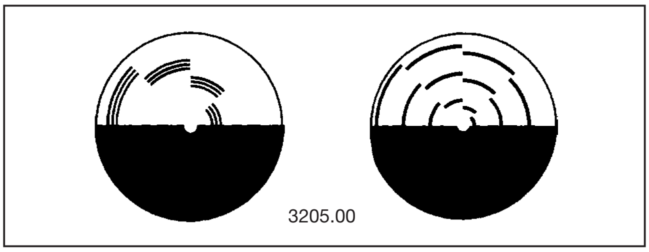
3089.00 Color filter, primary red
3089.10 Color filter, yellow
3089.20 Color filter, primary green
3089.30 Color filter, primary blue
3089.50 Color filter, cyan
3089.60 Color filter, magenta

Color filters, acrylic

Color filters produced with 3 mm thick, 50 x 50 mm acrylic plates suitable for use with the aperture supports items 2950.80 and 2970.00.

3085.00 Color filter, red
3085.10 Color filter, yellow
3085.20 Color filter, green
3085.30 Color filter, blue

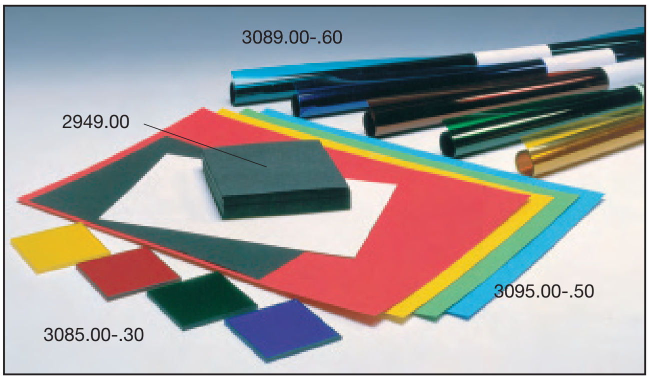




Colored filters, 10 pieces

Set of colored filters mounted in slides. Yellow, ruby, blue, red, green, cyan, magenta, purple, mat.

3090.90 Colored filters



Tricolour

Colour slide of the three primaries projected onto a screen and combining to produce the three secondary colours and white light.

3088.00 Tricolour slide

3088.00
DK-6870 Ølgod Denmark

Colour disc

Of stout card-board, diameter 300 mm, with three sets of seven spectrum colours correctly proportioned to appear white when rapidly rotated.

3200.00 Colour disc

Whirling apparatus

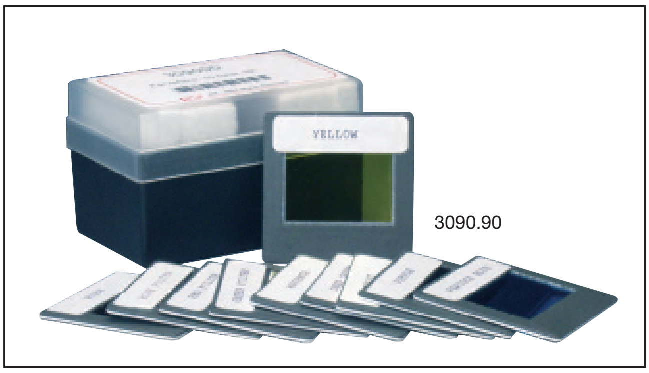
For rotation of colour disc no. 3200.00. Consists of handle with shaft and pulley with cord for rotation of shaft. The colour disc is fastened on a 8 mm thread with knurled nut. Length 160 mm, diameter 25 mm.

3202.00 Whirling apparatus

Discs with black/white patterns

The set contains two discs. They create the sensation of a color spectrum when rotated slowly. Disc diameter: 120 mm. The discs can be used with the motor with mounting axle item no. 2025.00.

3205.00 Discs with black/white patterns



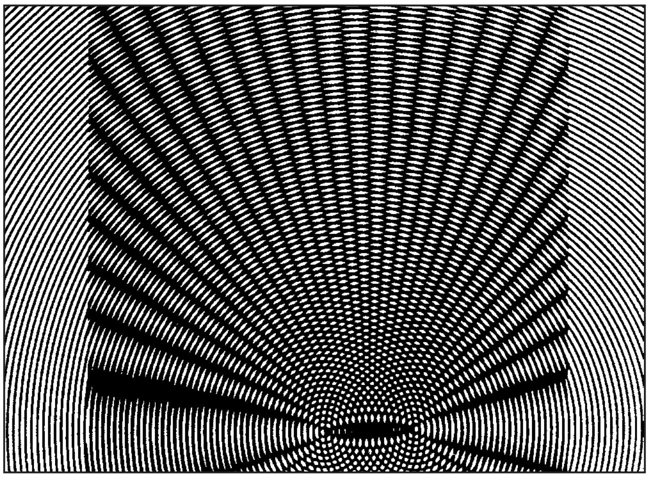
Interference, wavelength and polarizing

Pair of plastic ring plates

To illustrate interference between circular waves. One plate is 90 x 120 mm and the other is 90 x 90 mm. Both have a series of circular black groo-ves with increases in radius of 1 mm. The centres of the circles are 8 mm from the one edge of both plates allowing them to completely overlap or to be displaced by as much as 75 mm while maintaining a continuous interference pattern between the 2 centres. Ideally suited for overhead-projection.

3235.00 Pair of plastic ring plates

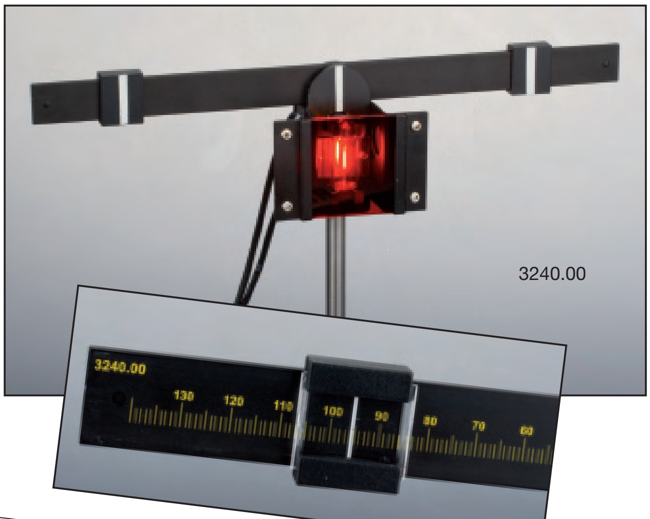
3235.00



Measurement of the wavelength of light

The apparatus is designed to measure the wavelength of light by studying the interference pattern from a double slit. The device contains a built-in 12 V auto lamp with a holder for color filters and a millimeter scale with phosphorescent moveable markers. The emitted light is viewed at a distance of about 3 meters through a double slit. The viewer then directs a co-worker to adjust the markers on the millimeter scale so that the distance between them corresponds to 10 interference maxima. Afterwards the distances can be measured and the wavelength of the light can be calculated. The equipment is well-suited to student lab exercises. Red and blue color filters and a double slit are provided. Power source required: 12 V AC/DC, 1.3 A.

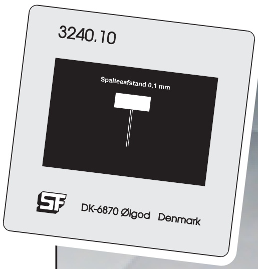
3240.00 Apparatus for determining the wavelength of light



Double slit

Mounted in a dias frame between two glass plates. Dimensions 50 x 50 mm. Spacing between slits 0.1 mm.

3240.10 Double slit



Single slits, various widths

This aperture consists of five different slit widths for demonstrations of diffraction patterns. Size: 50 x 50 mm.

3230.10 Single slits, various widths

Polarizing filters

Unmounted, can be cut with scissors.
Dimensions 50 x 50 mm. Pair.

3270.00 Polarizing filters

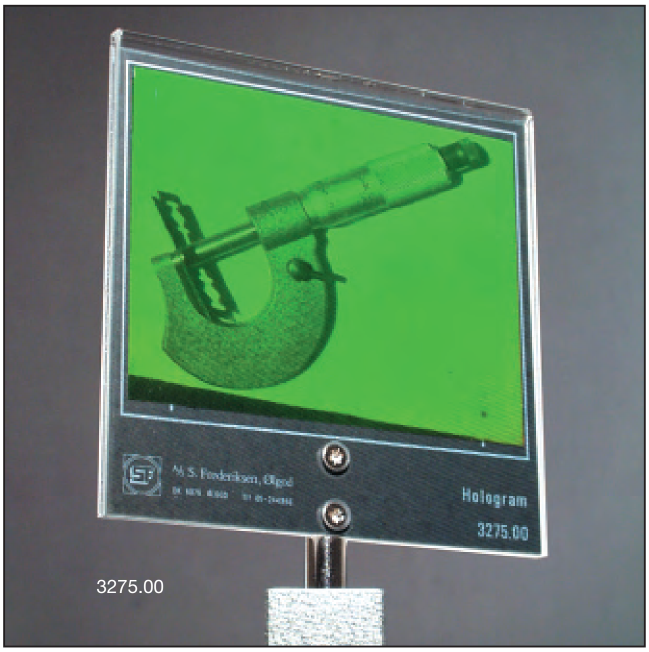
Polarising filter

Sheet of unmounted polarising filter, 21 x 16 cm.

3270.10 Polarising filter

3270.10
3270.00

Diffraction gratings see page 81.



3275.00

Holograms

Laser light is used to record holograms, because monochromatic, coherent light is required. When viewing holograms the demands on the quality of the illumination is not so critical, and holograms can be viewed and will give a 3D effect in ordinary white light.
An intense point source such as the sun or an intense halogen lamp are good light sources to use. Another possibility is to use light from a slide projector or overhead projector. The distance from an artificial light source should be about 2-3 meters.
The holograms listed below are reflection types.

Holograms in plasticframe

Protected against scratching.
Hologram dimension 12 x 9,5 cm. Frame 14 x 14 cm
Supplied with Ø 10 mm diameter fixing rod.

3275.00 Hologram in plasticframe

Holograms 5.5 x 5.5 cm

3276.10 Hologram, “Expo”

3276.40 Hologram, Frog

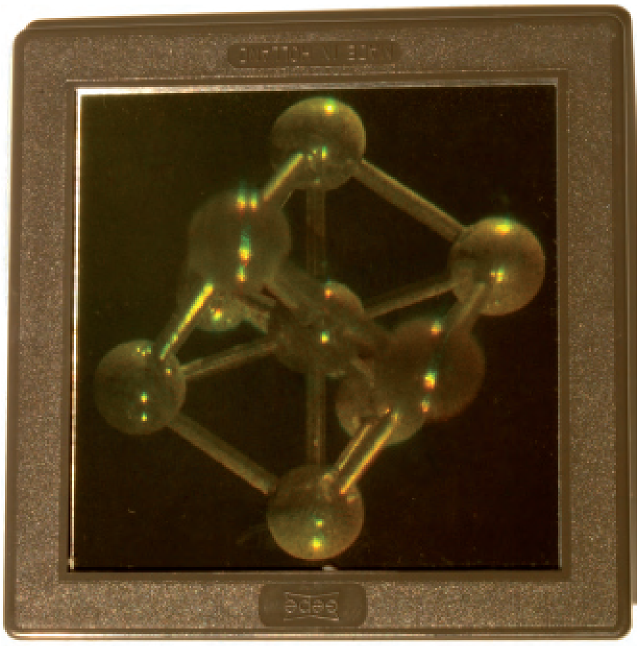
3276.60 Hologram, Coin

Holograms 10 x 13 cm

3277.30 Hologram, Mouse
3277.40 Hologram, Die

Hologram 24.4 x 21 cm

3278.10 Hologram, Kingfisher



3276.10

3278.10

Apparatus for the study of light energy

With this apparatus one can measure how much of the effect supplied to a filament lamp is converted into light and heat. The apparatus consists of a container with a built-in filament lamp and a resistor (of the same value as the lamp).

The container is filled with water and the temperature increases when the filament lamp is switched on, the resistance of both the lamp and the resistor can be measured.

Dimensions: Height 120 mm, diameter 70 mm.

3207.00 Apparatus for the study of light energy

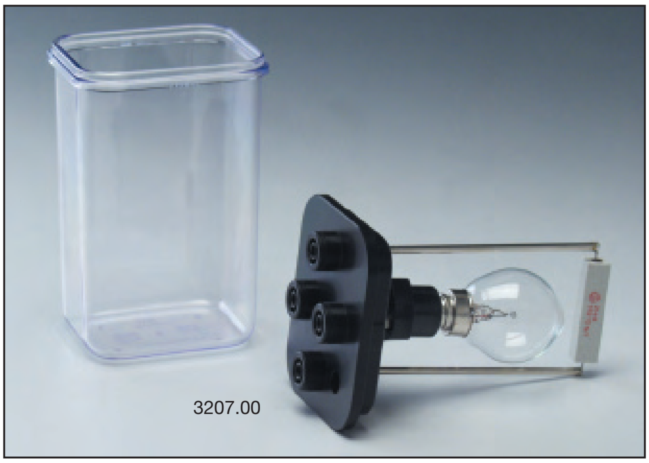
Zinc sulfide screen

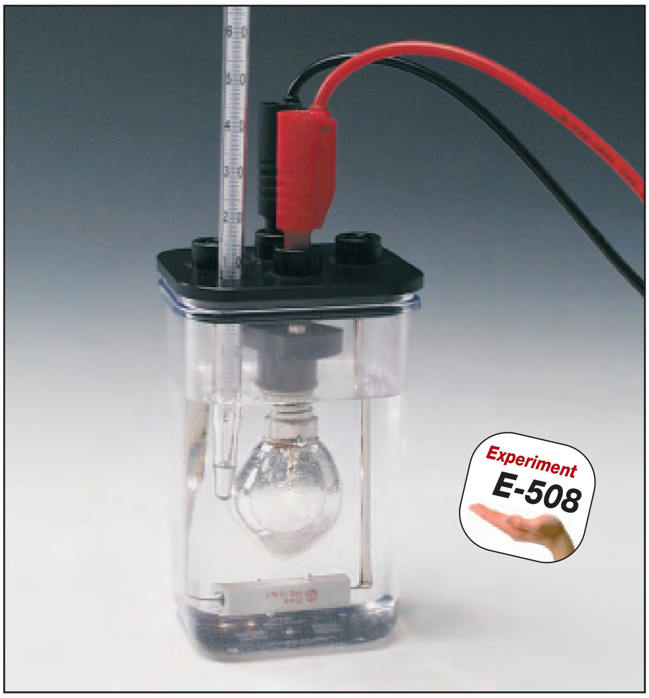
This phosphorescent screen will exhibit light emission some time after is has been illuminated. This effect depends upon the light source which also contains some ultraviolet light. The screen can thus be used to confirm that UV light is present in a light source. Can be used with the UV Accessory Kit no. 2872.10, the UV Lamp no. 2871.00 and the UV Probe no. 2872.00. Screen size: 110 x 105 mm. Mounted in a holder with a 10 mm diameter mounting rod.

3075.00 Zinc sulfide screen, without stand

3075.00

3075.00-3076.00


3207.00



Phosphorescent plate

As no. 3075.00 but 70 x 95 mm and unmounted.

3075.10 Phosphorescent plate

Fluorescent plate

This plate exhibits fluorescence when exposed to ultraviolet light. (In contrast to phosphorescent materials where visible light emission persists some time after exposure to the UV, fluorescent materials re-emit visible light only during exposure.) It can be used to demonstrate this phenomenon and to show how some materials (e.g. UV film in Accessory Kit 2872.10) filter out UV light. Size: 70 x 95 mm.

3076.00 Fluorescent plate

Light sensors

Sensors

The sensors illustrated below have been designed to measure the apparent intensity of visible light (lux), ultraviolet light (UVA and UVB) as the relative colors of red, green and blue light (RGB). The sensors are supplied with a 5-pole DIN connector and require a +5 VDC power supply. The sensors can be connected to computer interface system or to an ordinary voltmeter via battery box no. 2515.60.

UVA sensor, directional

Useful for the investigation of the emission from the sun, from halogen lamps, from solarium lamps etc., and the investigation of how UVA-intensity changes with distance. The measurement of light with the wavelength 370 nm +/- 5 nm only is ensured by a narrow band filter.
Provided with 5-pole DIN connector. (Requires a +5 VDC power supply.). Dimensions: diameter 24 x 99 mm.

2872.00 UVA sensor, directional

UVA sensor, table model

For the same uses as no. 2872.00, but designed as a table model.
Supplied with a teflon diffuser to detect light from all directions. Dimensions: Height 50 mm. Diameter: 60 mm.

2872.01 UVA sensor, table model

UVB sensor, table model

This sensor has been designed to follow the CIE response curve for reddening of the skin (erythemal response curve) in the UVB spectral region.
The sensor is therefore suitable for measuring the UVB-dose and subsequent evaluation of the risk of skin cancer after exposure to UVB radiation.
The sun is a very powerfull UV source and the sensor is well-suited for experiments measuring UVB from the sun and the effect of UV protection from sunglasses, suntan lotion, glass and so on.
Supplied with a teflon diffuser to detect light from all directions. The sensitive region is 280 – 315 nm.
Dimensions: Height 50 mm. Diameter: 60 mm.

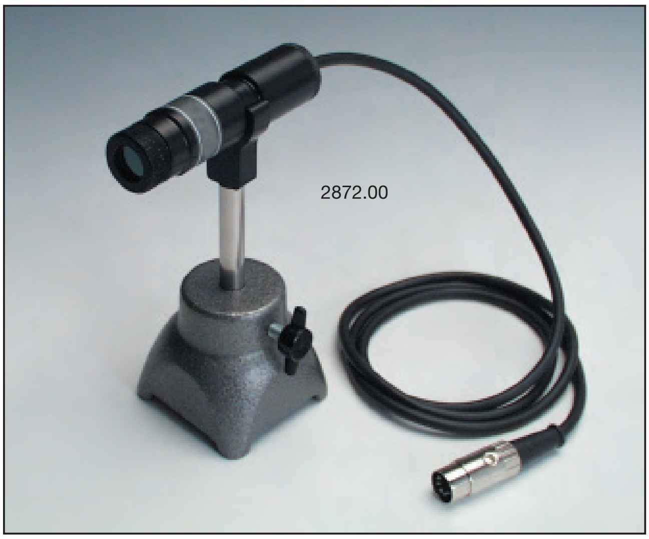
2872.61 UVB sensor, table model

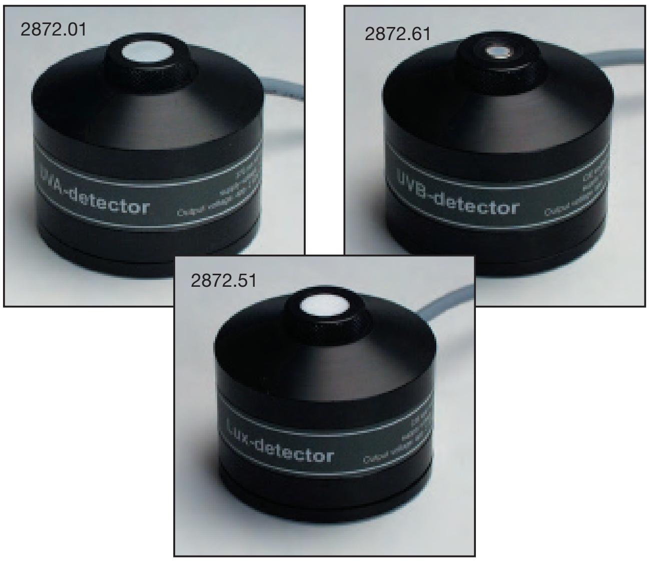
Infra-red (IR) sensor see page 64.

UVA-accessories

UVA- accessories consisting of standard glass plate, fluorescent plate, phosphorescent plate, UVA-filter, UVA plastic film and normal plastic film. For experimenting with ultraviolet light.

2872.10 UVA-accessories

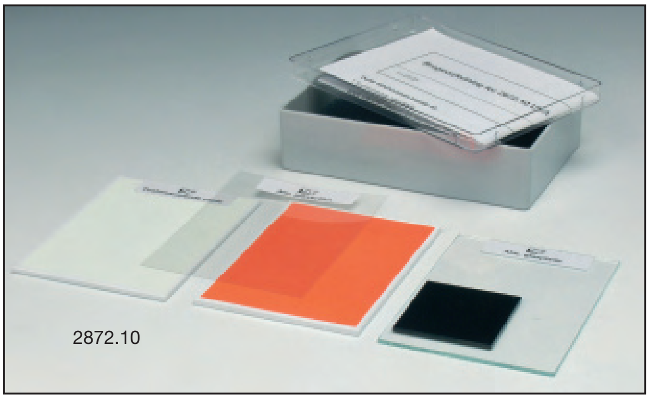




Lux sensor, table model

Provided with a photodetector, which has the same response curve as the eye (The CIE photopic response curve). The Lux Sensor exists only as a table model.
Supplied with calibration data.
Supplied with a teflon diffuser to collect scattered light.
Dimensions: Height 50 mm. Diameter: 60 mm.

2872.51 Lux sensor, table model



2872.71
RGB-detector
Lux-detector

All table model sensors are provided with a standard support rod thread to facilitate mounting in an experimental setup.

RGB sensor, table model

This sensor is provided with three output channels corresponding to red light (590 – 700 nm), green light (490 – 600 nm) and blue light (420 – 530 nm). The sensor is suitable for measuring cloud cover. On a cloudy day the response is almost the same from all three channels. If the sky is almost blue the signal from the blue channel is significantly larger than from the red and the green. Dimension: Height 50 mm. Diameter: 60 mm.

2872.71 RGB sensor, table model

Lux meter YF 1065

This digital lux meter is a robust and handy item provided with a separate safe-sealed photodetector for maximum stability. The photodetector has good spatial response so that it will respond to illumination from all directions. It is supplied with an analog output signal for connection to a chart recorder or other data collection instrument. This is useful when experimenting e.g. with photosynthesis. It is supplied complete with a battery and a convenient carrying case. LCD-display, battery powered and with separate photodetector.

Measuring ranges:	0-200 lux, 0-2000 lux, 0-20000 lux.
The angular response follows the cosine response with the following deviations:	30 degrees, less than +/-2%. 60 degrees, less than +/-7%. 80 degrees, less than +/-25%. Provided with a “hold” function for convenient measurement.
Analog output:	Jack connections (4 mm).
Size, instrument:	119 x 64 x 26 mm.
Photodetector:	125 x 66 x 36 mm.

1888.20 Lux meter YF 1065

Battery box for sensors

The battery box is designed for use with sensors and microphones which need + 5 VDC to operate.

The unit is provided with a battery compartment for a 9 V alkaline battery type 6LR61 (3510.10) which via an electronic regulator supplies the +5 VDC supply voltage for connected sensors.

The unit has one input terminal with a 5-pole DIN connector (180 degrees) for sensors and two input terminals with 6-pole DIN connectors (270 degrees) for microphones. The output terminals for attachment to a voltmeter, datalogger or other device are standard 4 mm safety-type jack connectors for the microphone output.

Dimensions (LxWxH): 14.3 x 8.4 x 3.7 cm

2515.60 Battery box

2515.60
Output
Battery Box
Input
Mic 1
Mic 2
Off
On
Sensor

1888.20
138.9
HOLD
DIGITAL LUX TESTER

Ultraviolet radiation

Ultraviolet light - properties and hazards

Measure the intensity of a UVA light source using this UV-probe. Because UV illumination can affect e.g. painted surfaces and fabrics, it can be desirable to use protective filters. Another example is skin-protective sun cream.

This equipment has been designed to illustrate the many interesting properties of ultraviolet light using protective film, clear film, ordinary glass and a Schott UV filter.

The set consists of: UVA lamp no. 2871.00, UVA probe no. 2872.00. Accessory kit no. 2872.10 with filters and other materials including fluorescent and phosphorescent plates. Complete instructions are supplied.

SAFETY NOTE: The light source is a UVA lamp emitting most UV radiation in the range 350-400 nm with a maximum around 370 nm. These wavelengths pose a minimum risk to eyes and skin, and the radiation does not generate harmful ozone.

2871.50 Ultraviolet radiation set

2871.00
2872.00
2515.60
2872.10

ADDITIONAL EQUIPMENT NEEDED

2515.60
1 ea. battery box

3867.50
1 ea. demonstration multimeter or

3862.15
1 ea multimeter for student use or any other D.C. voltmeter with high input resistance.

Optics set, student use

The following optics equipment has been manufactured especially for student use. Much of the equipment mentioned earlier in the Optics section can also be used by students.

Optics set, geometrical optics

Student ray track board

Constructed with a slightly sloping surface, allowing light tracing on the table surface with lined or graph paper. The table is in lacquered steel.
Dimensions: 260 x 180 mm, height 80 mm.

2915.00 Student ray track board

Lined paper

This sturdy, lined paper is for use with the Optics Table, item no. 2915.00. It is supplied with 1 cm^2 squares and with a wider center line marked. Lines parallel to the center line are numbered consecutively from the center line. Paper size: 179 x 239 mm.

2915.10 Lined paper, package of 25 ea.

Acrylic plastic blocks

For students use. Clear acrylic plastic 12 mm thick. With bottom surface finished in white, other surfaces fully polished.

2920.00 Triangular block 90°, 45°, side lengths 59 and 42 mm.

2920.10 Rectangular block, side lengths 50 and 19 mm.

2920.20 Biconvex block, 49 mm long.

2920.30 Biconcave block, 49 mm long.

2920.40 Semicircular block 80 mm long, radius of curvature 40 mm.

Plane mirror

Glass, black-silvered, mounted on hardwood cube. Side length 50 mm.

2925.00 Plane mirror

Cylindrical mirror

Made of polished stainless steel, side length 65 mm.

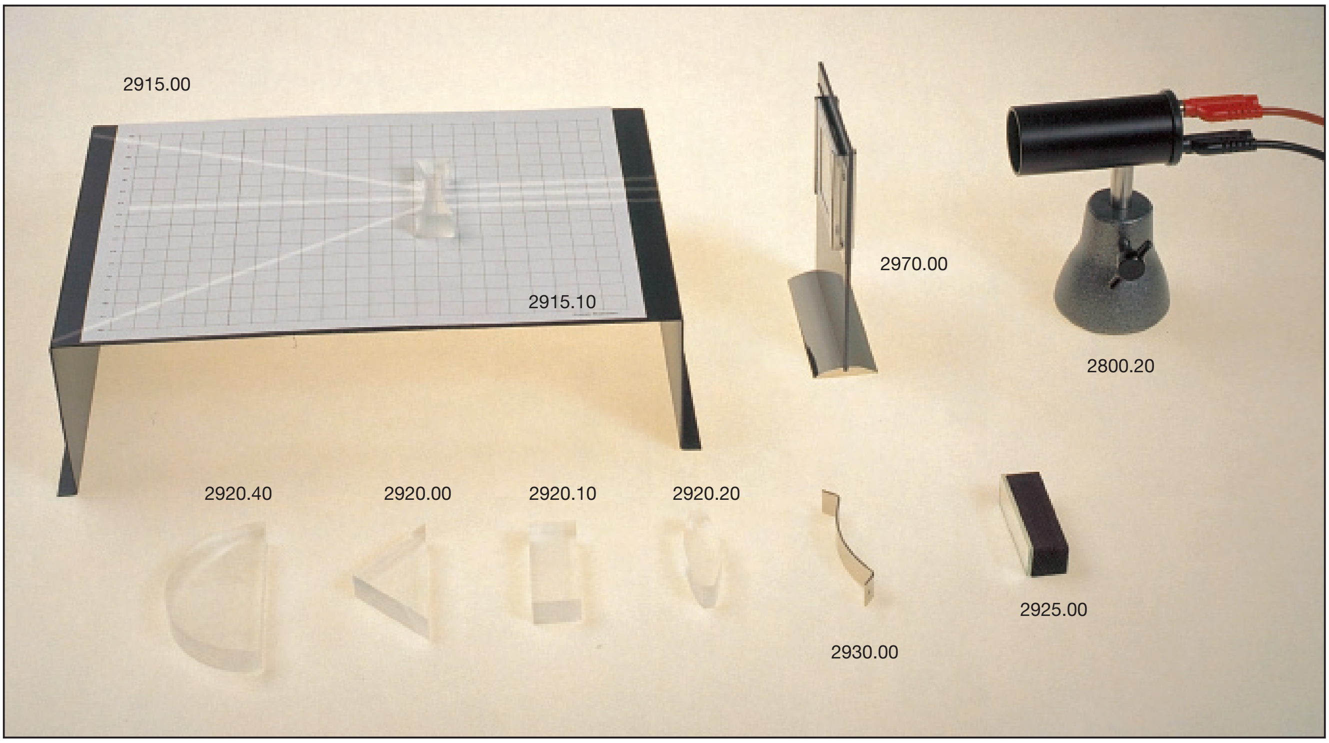
2930.00 Cylindrical mirror

ADDITIONAL EQUIPMENT NEEDED

2970.00 Slits and filterholder.

3010.00 Tripple slit.

0004.00 Retort stand base.
Power supply 6 V – 1 A AC/DC (3610.50)



Optics set, image formation

The student lamp no. 2800.20 or a candle in the adjustable holder no. 2820.00 can be used as a light source. The wooden ruler no. 1405.00 can be used to find focal lengths.

Lenses mounted in holder with guard

For student use. 40 mm diameter lenses mounted in rectangular plastic plate 80 x 120 mm with a heavy nickel-plated brass base. Engraved focal distance. Center height 83 mm. Can be used with light source no. 2800.20, slits and filter holder no. 2970.00, and ruler no. 1405.00.

2965.00 Lense in holder, + 300 mm

2965.10 Lense in holder, + 100 mm

2965.20 Lense in holder, + 50 mm

2965.30 Lense in holder, - 200 mm

Slits and filter holder

Designed to accept slits and filters etc. 50 mm square by a maximum of 3.5 mm thickness. 80 x 120 mm. Plastic guard with heavy nickel-plated brass base. Center height 83 mm.

2970.00 Slits and filter holder

Glass plate

Plane rectangular 180 x 120 mm, 2 mm thick.

3040.00 Glass plate

Glass plate, frosted

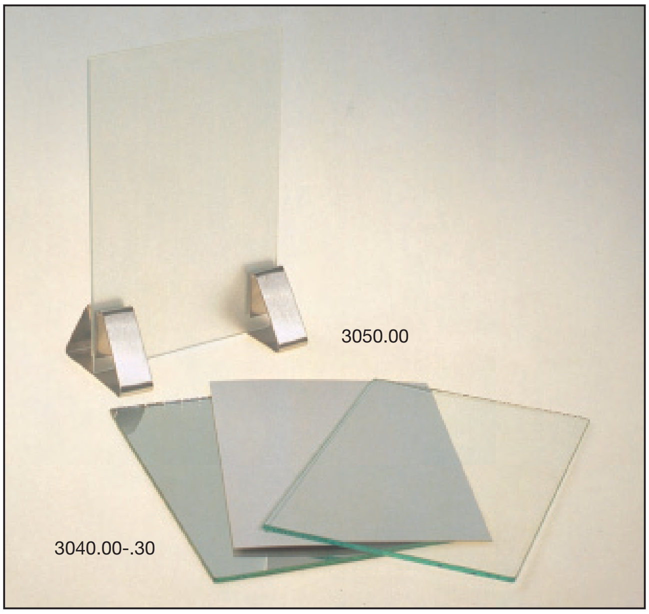
Plane rectangular 180 x 120 mm, 2 mm thick.

3040.10 Glass plate, frosted

Plane mirror

Glass, back-silvered with protective coating. Rectangular 180 x 120 mm.

3040.20 Plane mirror



3050.00

3040.00-.30

Guard

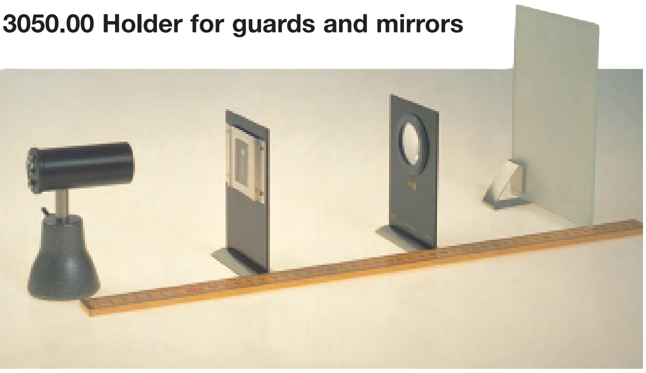
In white plastic plate. Side length 180 x 120 mm.

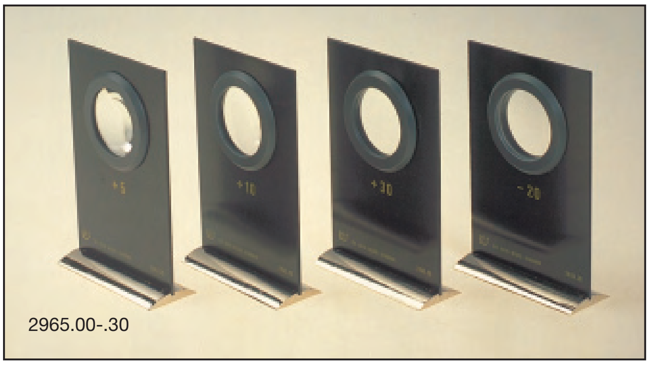
3040.30 Guard

Holder for guards and mirrors

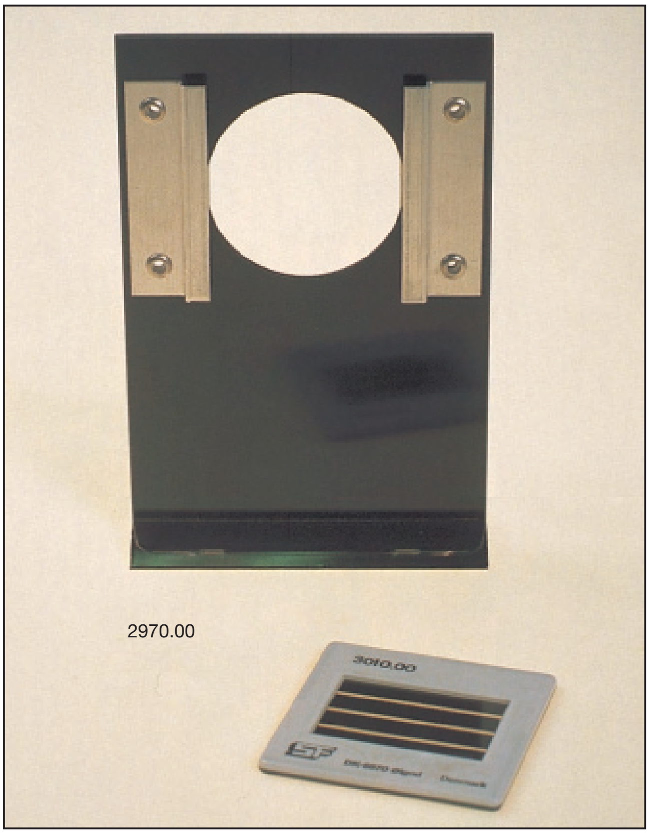
In polished stainless steel. Width 20 mm, height 40 mm, thickness 1 mm.

3050.00 Holder for guards and mirrors





2965.00-.30



2970.00

Magnetism

Iron ore, magnetic

Specimen for demonstration.

3300.00 Iron ore, magnetic

Bar magnets, Al-Ni-Co

Cylindrical magnets, 11 mm diameter, length 170 mm, with keepers and colored poles. Supplied in a wooden holder.

3305.00 Bar magnets, Al-Ni-Co

Bar magnets, Al-Ni-Co

As 3305.00 but without wooden holder.

3305.01 Bar magnets, Al-Ni-Co

Bar magnets, Al-Ni-Co

Pair of square section magnets 10 x 10 mm. Length 100 mm with colored poles.

3305.10 Bar magnets, Al-Ni-Co

U-Shaped magnet, Al-Ni-Co

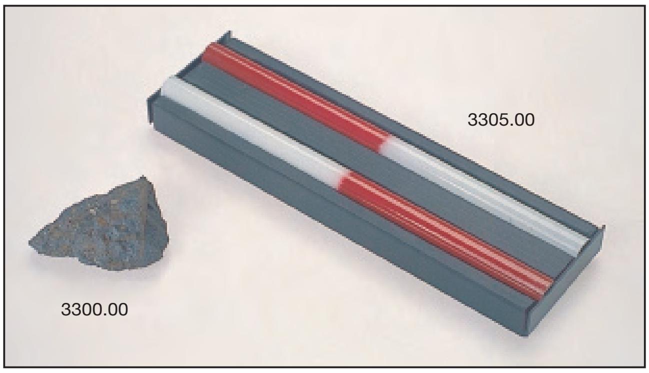
A magnetized Al-Ni-Co block attached to two parallel mild steel pole pieces. Overall dimensions 30 x 82 x 135 mm. Distance between poles 59 mm. With keeper and colored poles.

3315.00 U-Shaped magnet, Al-Ni-Co

U-Shaped magnet, Al-Ni-Co

As no. 3315.00 but smaller. Overall dimensions 15 x 60 x 90 mm. Distance between poles 48 mm.

3315.10 U-Shaped magnet, Al-Ni-Co



Cylindrical magnet, Neodymium

Diameter 30 mm, thickness 6 mm. Mounted in a holder on a 10 mm diameter stainless steel rod.
Can be used in conjunction with induction coils for the demonstration of alternating current - AC.

3320.00 Cylindrical magnet

Cylindrical magnet, Neodymium

As no. 3320.00, but with ball bearing and pulley.

3320.10 Cylindrical magnet

Bar magnets, Al-Ni-Co

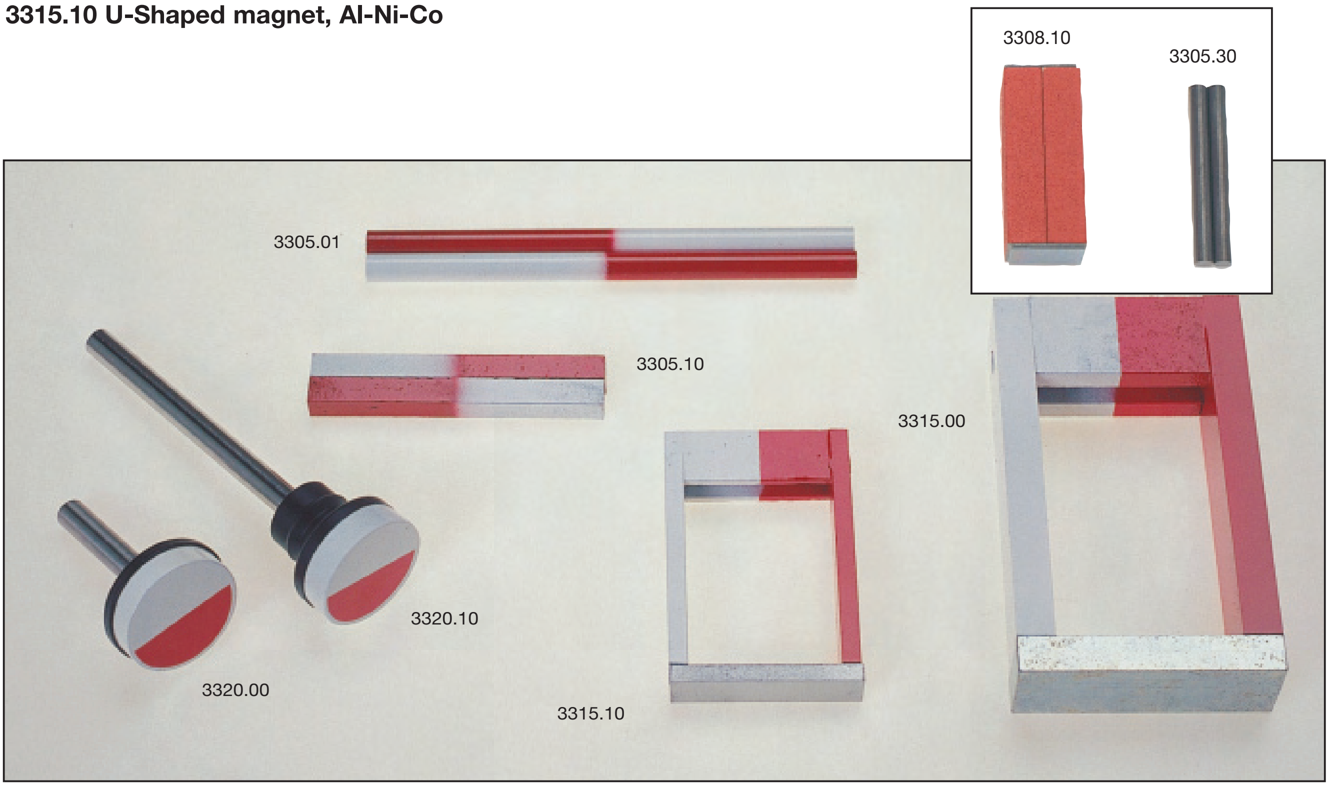
Pair of cylindrical magnets, 5 mm diameter, length 50 mm.

3305.30 Bar magnets, Al-Ni-Co

Bar magnet Al-Ni-Co

Pair of square section magnets 15 x 10 mm. Length 50 mm.

3308.10 Bar magnet Al-Ni-Co



Neodymium magnets

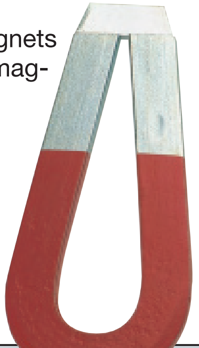
Neodymium Magnets are rare earth magnets containing iron, neodymium and boron. These magnets are so powerful that they can be used to manufacture magnets. They are capable of detecting magnetic properties in materials you would never have expected. Whenever the topic of magnetism is touched upon these magnets are excellent for illustrating magnetic properties. Great for induction experiments. Place a magnet on either side of the palm of your hand just to illustrate how powerful they are.

3318.00 Neodymium magnets Ø 10 x 6 mm, boxed pair

3318.10 Neodymium magnets Ø 10 x 8 mm, boxed pair

3318.20 Neodymium magnets Ø 14 x 8 mm, boxed pair

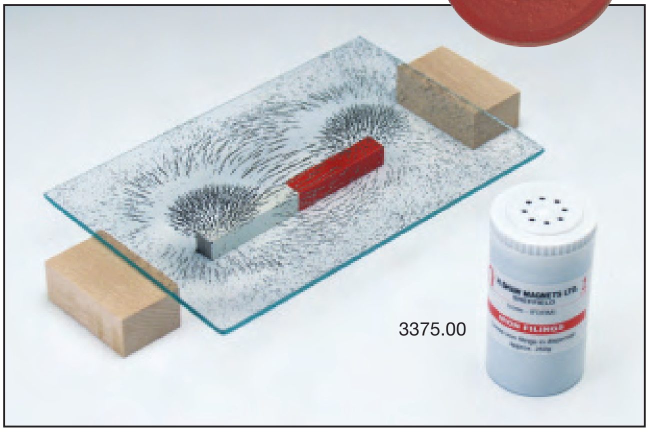
Warning. Never store or use these magnets near diskettes, credit cards or other magnetic media.

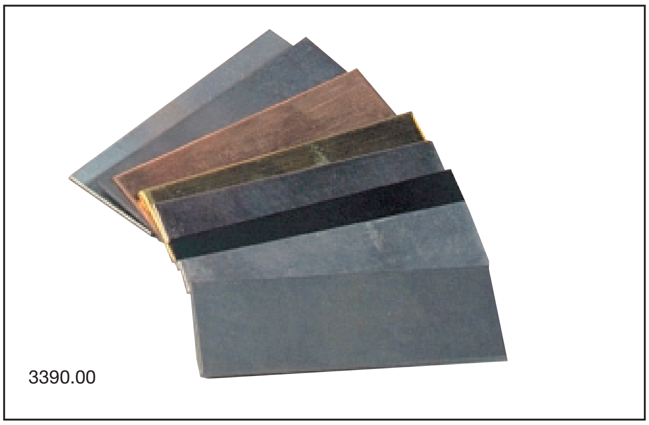

3315.30

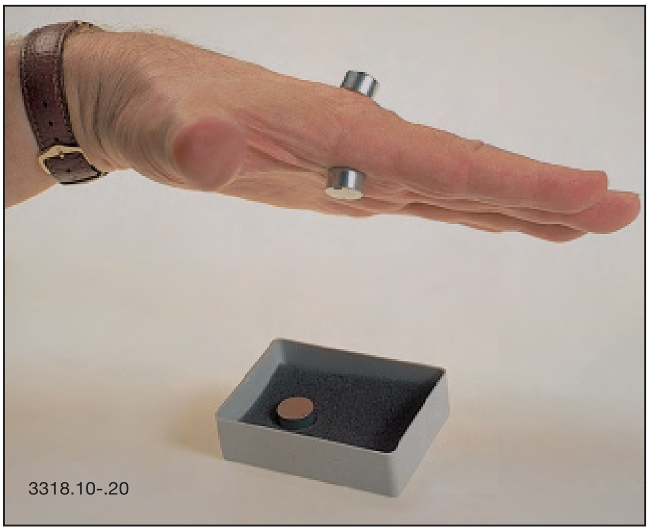
Horseshoe magnet

Made of 6 % chrome steel, with keepers, overall length 125 mm.

3315.30 Horseshoe magnet


3375.00

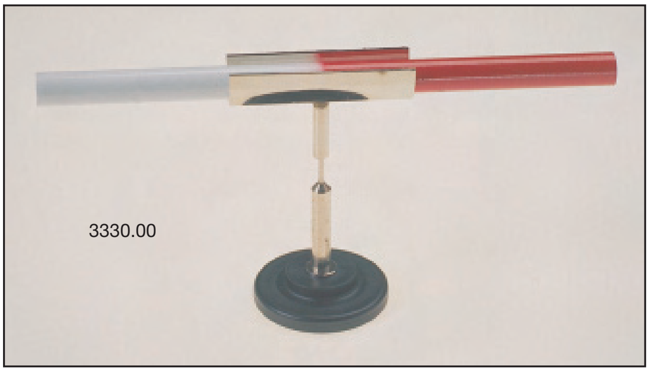

3390.00


3318.10-.20

Support for Bar magnet

For holding a bar magnet to demonstrate repulsion and attraction. Made of nickel-plated brass. Requires a stand e.g. no. 3415.00. For magnets up to max. 11 mm square or diameter.

3330.00 Support for Bar magnet


3330.00

Iron filings

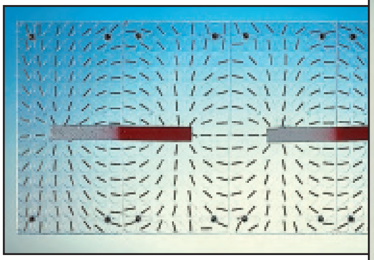
150 g in polythene shaker for sprinkling filings.

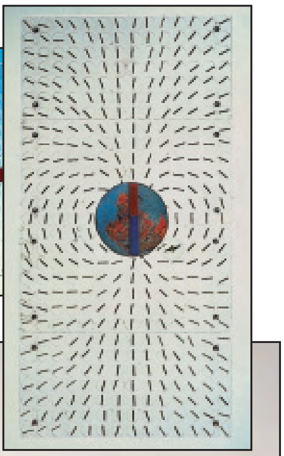
3375.00 Iron filings

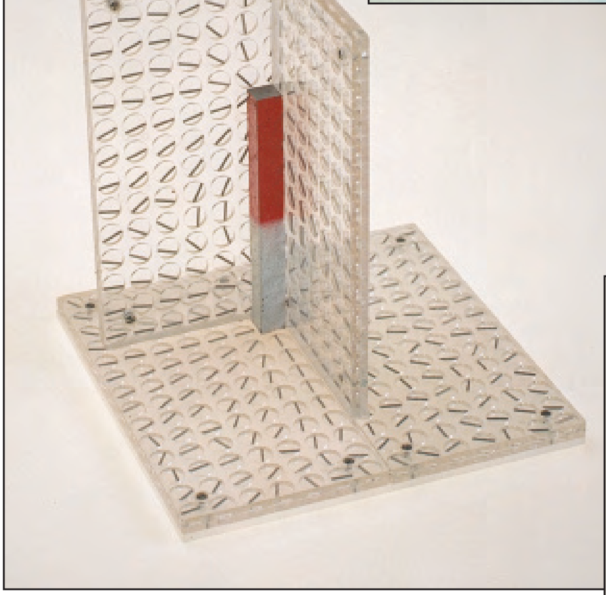
Materials set for magnetism

Consists of 8 plates of magnetic and non-magnetic materials each 65 x 25 mm. Materials provided are: Brass, nickel, lead, copper, aluminium, iron, zinc and plastic.

3390.00 Materials set for magnetism







Magnetic field demonstrator

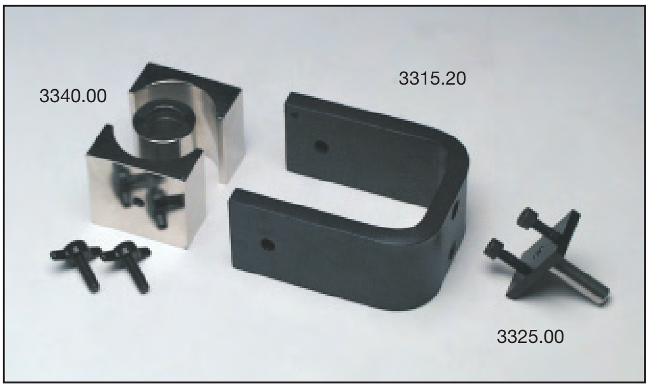
Elegant and easy to use - no messing about with iron-filings. The perfect aid for clearly revealing the magnetic field lines in 1, 2 or 3 dimensions. Equally suited for demonstration purposes and student experiments.
A number of unique experiments can now be performed with this new Magnetic Field Demonstrator kit.
The kit consists of 4 plastic plates which contain total of 392 small 8 mm magnetic pins. Dimensions of each plate 153 x 77 x 6 mm. The plates are transparent which means that experiments can be visually displayed by means of an overhead projector. The kit may be utilized exactly as you like, each plate separately or 2, 3 or 4 covering a larger area. For 2- or 3-dimensional demonstrations simply set as many as required on end.
In addition to the traditional experiments a number of interesting phenomenons may be demonstrated by means of the Magnetic Field Demonstrator kit, such as magnetic fields with several layers, the magnetic field of the earth and the magnetizing process. In the latter experiment, 4 plates are stacked and their combined 376 magnetic pins represent elementary magnets in a demagnetized piece of steel. A bar magnet is drawn over the plates and the magnetic pins then form a unidirectional field pattern with North and South poles.
Test with a magnetic needle. By shaking or knocking the “magnet” it becomes demagnetized and the magnetic pins (elementary magnets) form a random pattern.

3395.20 Magnetic field demonstrator

U-Shaped magnet

Made of chrome steel, with keepers. Dimensions 107 x 85 x 50 mm. Distance between poles 64 mm

3315.20 U-Shaper magnet



Pole shoes and core

For demonstration of magnetic field.
Suitable for U-Shaped magned 3315.20.

3340.00 Pole shoes and core

Magnet holder

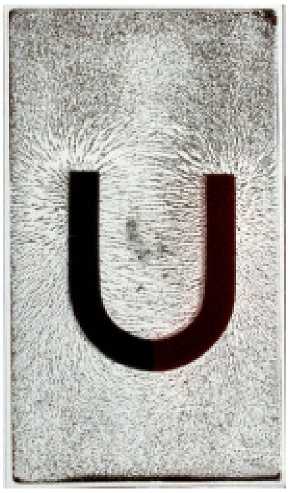
Magnet holder for U-Shaped magnet 3315.20.
For rotating the magnet in longitudinal direction.

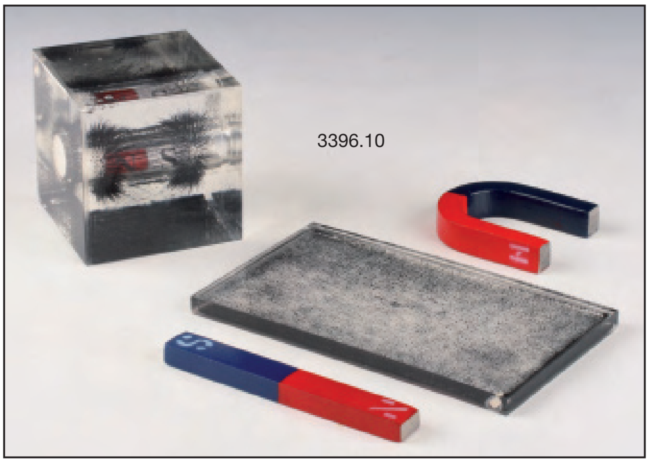
3325.00 Magnet holder

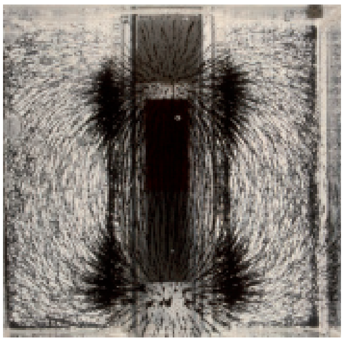
Magnetic field demonstrator

For demonstration of two and three dimensional magnetic field lines. The set includes a magnetic field box, a magnetic field plate and three magnets (2 bar magnets and a horse shoe shaped magnet). The magnetic field box as well as the plate contains iron file flakes suspended in viscous liquid. In the middle of the box is placed a magnet forcing the iron file flakes to turn to display the field lines. Likewise it is possible to place a magnet on the plate to visualize the field lines. Dimension - box: 76x76x76 mm, plate: 91x157x9 mm.

3396.10 Magnetic field demonstrator



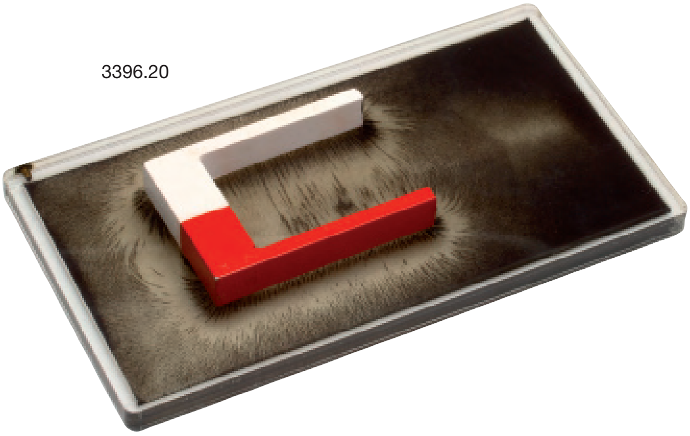

3396.10

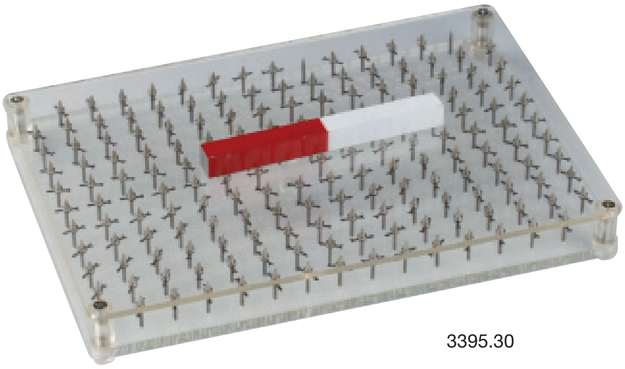


Magnetic field demonstrator

For demonstration of two dimensional magnetic field lines. When a magnet is placed on top of the box the iron file flakes within the box turns to display the field lines. Magnet not included. Dimension: 223x122x11 mm.

3396.20 Magnetic field demonstrator

3396.20



3395.30

Magnetic field demonstrator

For demonstration of two dimensional magnetic field lines from a magnet placed on top of the box. The box consists of 11 x 16 small arrow shaped, needle mounted magnets in acryl housing. Dimension: 15x15 cm.

3395.30 Magnetic field demonstratorer

Compass, transparent

This compass is useful in demonstrations of magnetic field strength. The compass needle is supported in a sealed plastic housing with transparent top and bottom. Well-suited for use on an overhead projector. Diameter: 19 mm. Package of 12 ea.

3400.10 Compass, transparent, 1 ea.

Pocket compass

Nickel-plated brass case. Dial 360°, white with stop. Diameter 45 mm.

3405.00 Pocket compass

Compass SILVA type 3

Transparent base plate 11 x 54 mm, with magnifying lens and scales. Rotatable capsule, agate pivot, red/ black north-south lines. Dial 360° international, Ø 50 mm with grid.

3405.15 Compass SILVA type 3

Pocket compass

Low cost pocket compass with 360°/5° graduation. Nickel plated brass housing. Needle placed on stone bearings. Diameter 40 mm.

3405.05 Pocket compass

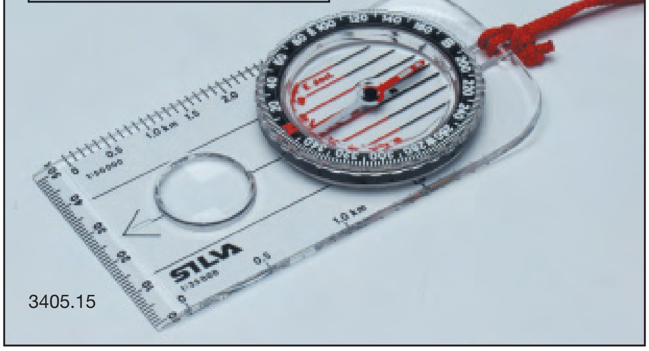
Compass, low-costs

Land compass with 360° graduation. Transparent base plate. Liquid filled compass housing.

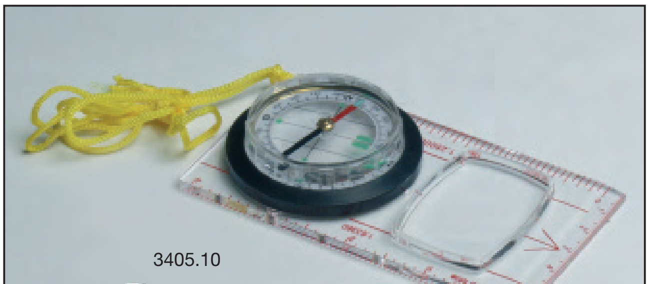
3405.10 Compass, low-costs

3400.10

3405.00



3405.15


3405.10

3405.05

3405.18

Storage container for 3405.15

Suitcase with lining for storing up to 24 SILVA compasses (no. 3405.15).

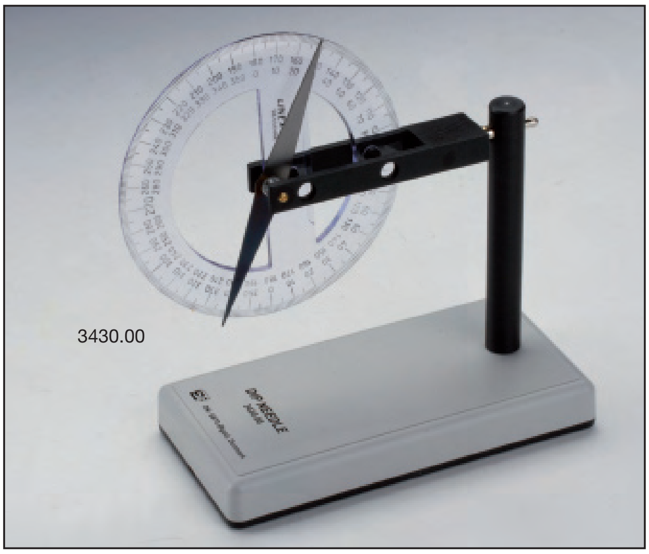
3405.18 Storage container for 3405.15

Demonstration compass f. OHP

Same specifications as 3405.15. Model for Overhead Projector, size: 48 x 25 cm. Ideal for demonstrating how to use a compass.

3405.16 Demonstration compass f. OHP

READ BEARING HERE
SILVA
3405.16



Dip needle

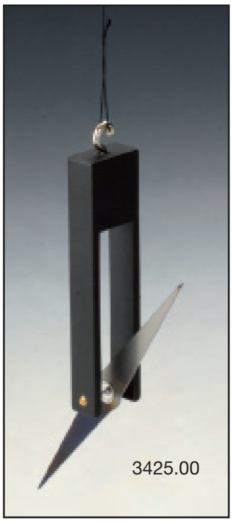
With magnetic steel needle, 105 mm long, fully rotatable. Mounted in holder with agate cup bearings and suspension hook.

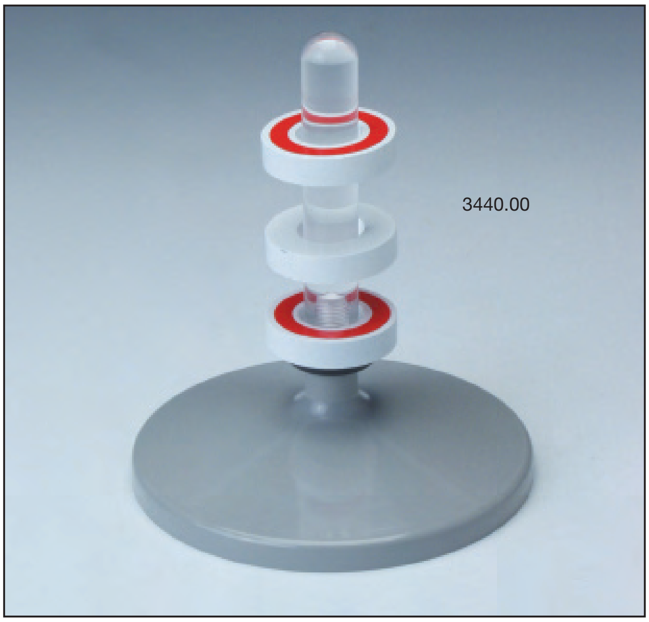
3425.00 Dip needle

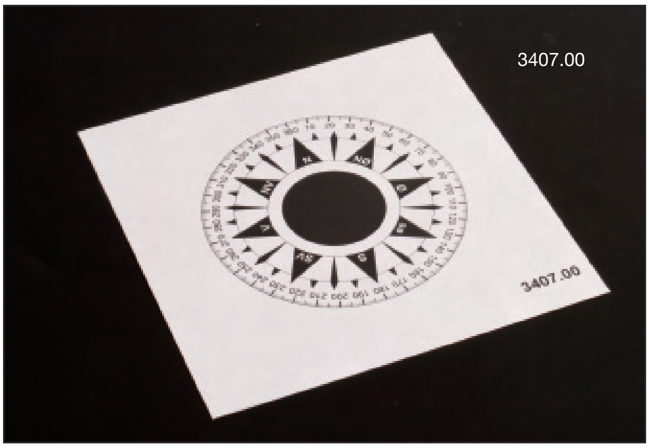
Dip needle

With magnetic steel needle, 105 mm long, fully rotatable. Mounted in a holder with agate cup bearings and inclination scale. The system can be moved from the vertical to the horizontal plane and serve as an ordinary magnetic needle.

3430.00 Dip needle



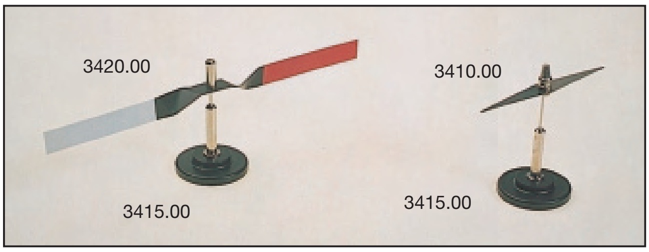




Compass card, cardboard

A replica of a compass card mounted on cardboard. The diameter of the compass card is 65 mm.

3407.00 Compass card, cardboard



Magnetic needle

Carbon Steel with nickel-plated brass bearing pivot. Length 110 mm, supplied without stand.

3410.00 Magnetic needle

Stand for magnetic needle

Non-magnetic metal pillar with carbon steel point on stable base. Height 110 mm.

3415.00 Stand for magnetic needle

Demonstration magnetic needle

Length 150 mm with coloured polarity indication and agate cup for needle base. Including needle on base.

3420.00 Demonstration magnetic needle

Suspended magnet

Three ring-shaped ceramic magnets, axially magnetized, mounted on a clear plexiglass rod in order to repulse each other.
Diameter of magnets 40 mm. Total height 135 mm.

3440.00 Suspended magnet

Ring shaped magnet

Ring shaped ceramic magnet with axially directed field. To be used with 3440.00. Dimension: Outer/inner diameter: 36 mm / 17 mm. Height: 8 mm.

3440.01 Ring shaped magnet

Round magnet with ring

Circular ceramic magnet glued to a plastic plate and mounted with eye. Dimension: 10 mm x Ø 20 mm. Used with dynamometer to determine magnetic field force.

3450.00 Round magnet with ring

Pole finder for magnets

Pole Finder for determination of magnetic north/south. LED indication.

4060.40 Pole finder for magnets

Lenz law kit

Copper tube, length 18 cm, and two ring shaped neodymium magnets.

4602.10 Lenz law kit

Lenz’ Law, open version

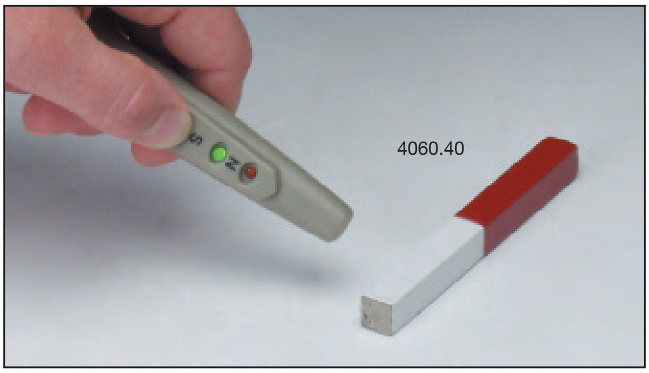
For demonstrating the nature of eddy-current
Length 1 metre. Delivered with 2 magnets and two dummies made of stainless steel

4602.20 Lenz’ Law, open version

Magnaprobe

Designed for work with magnetic fields in the laboratory. Alternative to plotting compasses when investigating the fields around magnets or coils etc.

3435.00 Magnaprobe

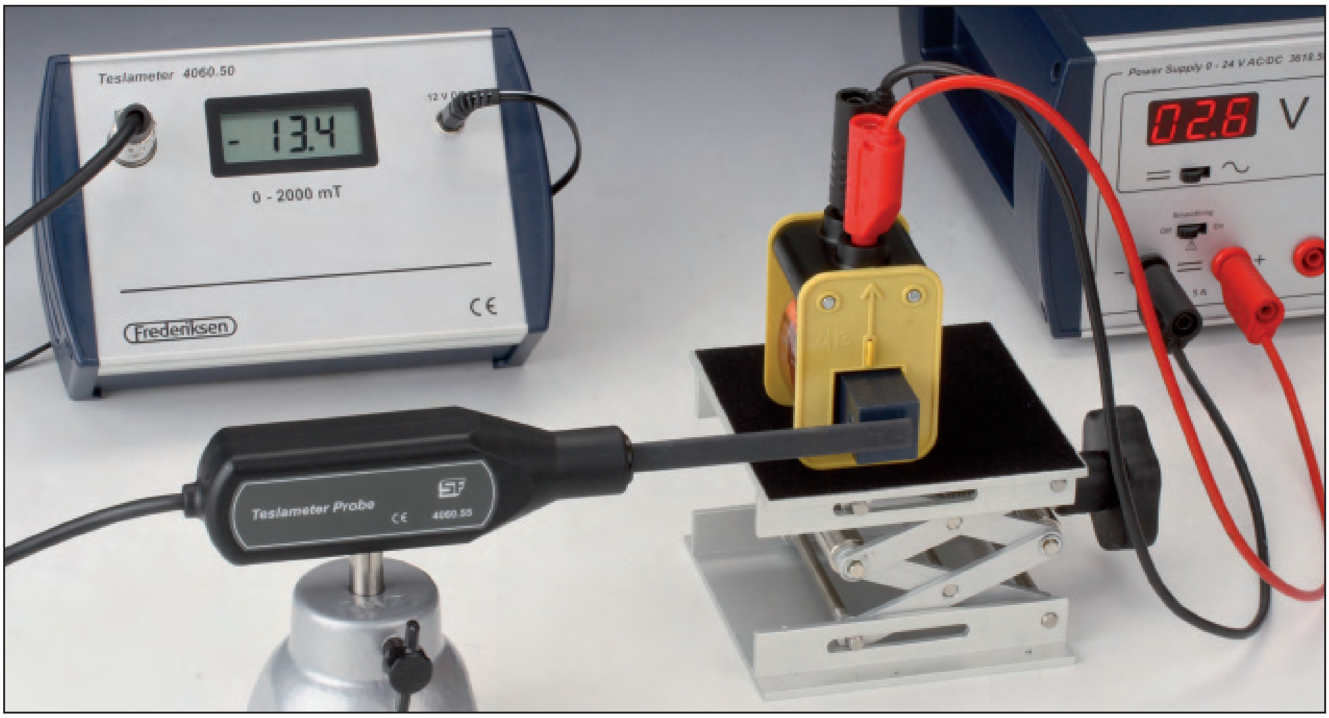


4060.50
Teslameter 4060.50
0 - 2000 mT
Frederiksen
Teslameter Probe

Teslameter

This simple, user-friendly instrument is designed to measure high magnetic fields e.g. from AlNiCo magnets, coils and electromagnetic experiments. An auto scaling feature provides automatic switching between measuring ranges:
1-200 millitesla (mT) and 0.01 - 2 tesla (T).
Measuring ranges:
0.01 - 2 T, 1 mT resolution.
1-200 mT, 0.1 mT resolution.
Accurancy: 5%.
Size:
Magnetic field probe (without holder):
80 mm long, 8 mm wide, 2 mm thick.
Readout instrument: 158 x 108 x 56 mm.
Includes powersupply for 230VAC European plug

4060.50 Teslameter


Teslameter 4060.50
- 13.4
0 - 2000 mT
Frederiksen
Teslameter Probe
4060.55
Power Supply 0 - 24 V AC/DC
02.6
V

NEW!
Laboratory Power Supply

- **Weight reduction from 7.8 to 2.5 kg**
- **Simultaneously readout of voltage and current for AC and DC**
- **Improved sinus waveform for AC**
- **Higher efficiency – lower temperature**

Power supply 0-24 V AC/DC

This power supply features continuous regulation from 0-24 V AC and DC. It can be connected to separate loads to the DC and the AC connections, and the voltages can be set separately. It also permits simultaneous digital readout of both the AC and DC voltages and currents.
The supply has continuous regulation of DC current in the entire current range, and a fixed AC current limiter is provided. It is electronically protected against overloads. LED indicators in both the DC and AC ranges indicate whether or not the current supplied has reached the upper limit, in which case the built-in current regulation will reduce the output voltage.
This CE approved power supply with safey transformer fulfills the requirements of the EN 61558-1 standard. The power supply outputs are safety jack connectors and these live up to the safety requirements of the Danish Electricity Council.

Switch mode regulation (SMPS):

The combined requirements for high current levels, low operating temperature and compact size are best met by using switched mode regulation. This is the ultimate means of avoiding heating problems and wasted energy. The dependability and lifetime of the power supply is enhanced due to lower operating temperatures for all circuit components. The supply fulfills all requirements with respect to noise emission. The supply also boasts low weight compared with traditional power supply solutions. This is a user-friendly power supply with a large capacity. The simple and logically arranged control panel reduces the possibility of incorrect use. The unit is sturdy and compact. It can operate hour after hour at maximum rated current capacity without overheating. The unit fulfills EU's requrements for CE-marking and the low voltage directive.

DC Specifications:

- Voltage: 0-24 V DC smoothed, stabilized and continuously adjustable.
- Noise and ripple: Less than 25 mV.
- Current: Up to 10 A.

AC Specifications:

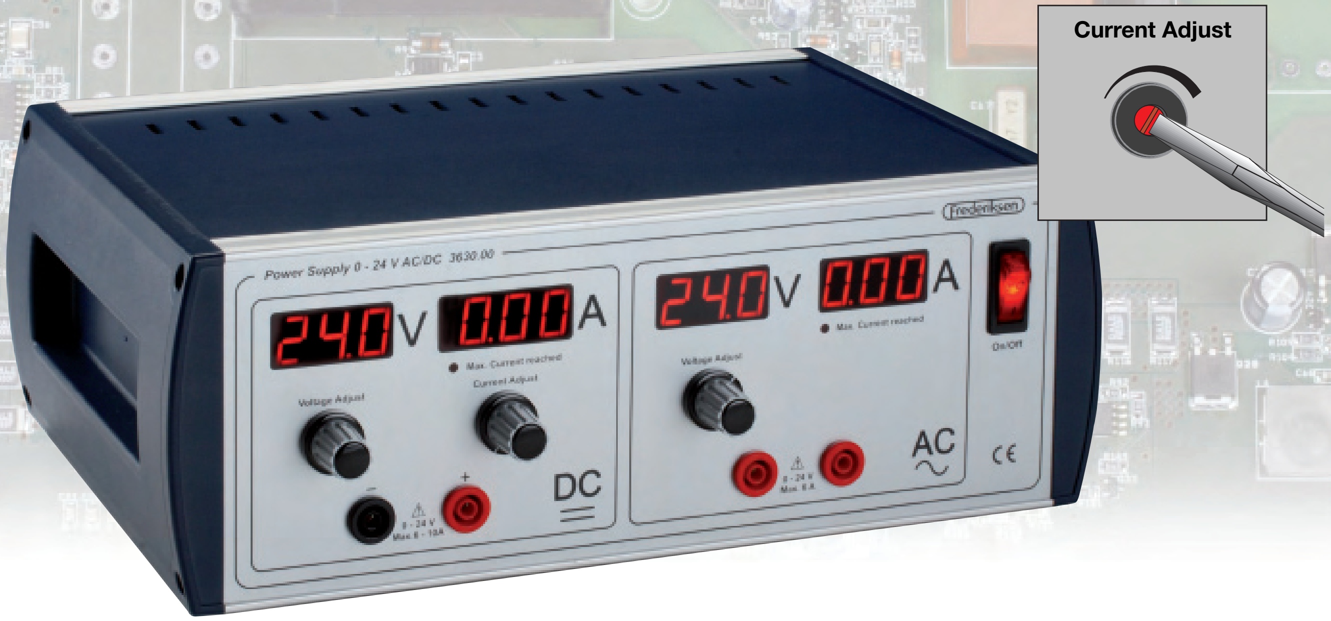
- Voltage: 0-24 V AC continuously adjustable.
- Current: Max. 6 amperes.
- Frequency: The same as the line voltage (50-60Hz)
- AC/DC: Electronically protected against overloading.
- Switched readout for AC/DC voltage and current.
- Line voltage: 230 V AC.
- Size: 297 x 225 x 118 mm.
- Mass 2.5 kg. (Net weight of power supply)

3630.00 Power supply 0-24 V AC/DC

Power supply 0-24 V AC/DC

Similar to 3630.00 but current limiter is operated through a hole in the front using a screw driver.

3630.10 Power supply 0-24 V AC/DC



High voltage supply with smoothed and stabilized DC voltage 0-500 V power supply

The perfect choice for experiments with electron beams or those requiring voltages up to 500 V but at a low current level. The unit also provides an continuously variable output of 0 to -50 V DC. Voltage and current can be read from separate displays allowing the user to monitor either of the two ranges 0 to +500 V or 0 to -50 V.

The power supply even has six independent outlets for fixed AC voltages, a very useful feature for filament heating. All outputs are equipped with automatic thermal cutoff for overload protection.

Technical Specifications:

DC

Voltage: -50 - 0 - +500 V continuously variable.
Current: Max. 50 mA.
Ripple: Less than 0.1%.

AC

Voltage: Fixed outlets at 2, 3, 4, 5, 6 and 7 V.
Current: Max. 50 mA.
Supply: 230 V AC, 50 Hz.
Size: 297 x 225 x 118 mm.
Mass: 4.55 kg.

3655.60 0-500 V Power supply

502 V
000 mA
DC
AC
2
3
4
5
6
7
Frederiksen

0-500 V power supply

Similar to the 3655.60 but max. 2 mA current.

3655.65 0-500 V Power supply

0 - 6000 V DC power supply

The 6 kV DC voltage output is centered around ground with +3 KV and - 3 kV centered around the zero point. This unit is ideal for experiments with electron beam tubes, electrostatics and Millikan's apparatus to name a few. For safety reasons the current is limited to 0.1 mA at maximum voltage and to 1.4 mA at the lower voltages.

Technical Specifications:

DC

Voltage: -3000 - 0 - +3000 V DC, max. 6000 V DC.
Current: 0 - 4 kV: 1.8 mA, 4-6 kV: 0.1 mA.
Ripple: Less than 0.1%.

AC

Voltage: 6.3 V AC.
Current: 3 A.
Supply: 230 V AC, 50 Hz.
Size: 297 x 225 x 118 mm.
Mass: 4.8 kg.

3660.50 0 - 6000 V DC power supply

Voltage Adjust
Frederiksen

3660.50

Non-stabilized power supplies

Power supply 1-12 V AC/DC

A straight-forward and sturdy power source. Equipped with automatic thermal cutoff for overload protection. A good (and economical) choice for primary schools, beginners' student labs for simple experiments with lamps, resistors, etc.
Stepwise regulation of both AC and DC at 1 V increments. Readout of both AC and DC voltages by means of a marked scale and a pointer knob.

Technical Specifications:

DC

Voltage: Adjustable 1 - 12 V DC in 1 V increments.
Current: Max. 6 A full wave rectified.

AC

Voltage: Adjustable 1 - 12 V AC in 1 V increments.
Current: Max. 6 A.
Supply: 230 V AC, 50 Hz.
Size: 185 x 225 x 118 mm.
Mass: 2.8 kg.

3610.50 Power supply 1-12 V AC/DC

3610.50

3618.50

Power supply 2 - 24 V AC/DC

A power supply like 3610.50 but with a voltage range from 2 to 24 V in 2 V increments.
Supplies max. 5 A AC/DC.

3610.60 Power supply 2 - 24 V AC/DC

Power supply 24 V AC/DC

Continuously variable AC and DC outputs. The DC output is partially smoothed by means of a capacitor. Digital readout of both AC and DC voltages. Electronically protected against overloads.

Technical Specifications:

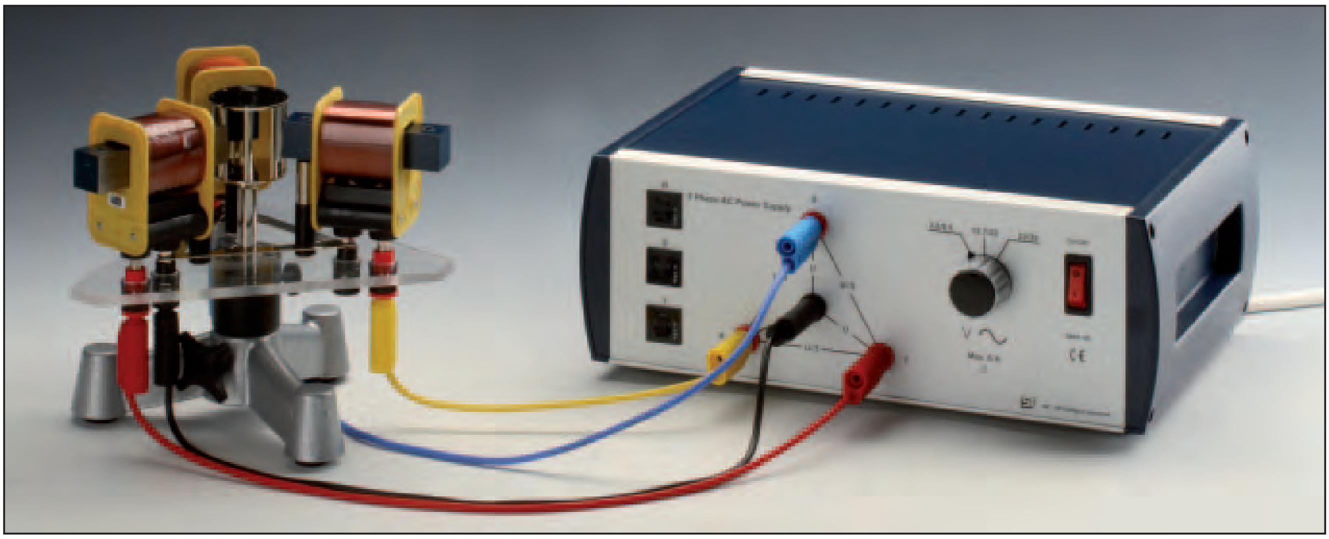
DC

Voltage:	0-21 V continuously adjustable without smoothing. 0-32 V continuously adjustable with smoothing.
Current:	Without smoothing max. 5 A. With smoothing max. 3 A.
Ripple:	With smoothing: ca. 4%.

AC

Voltage:	0-25 V continuously adjustable. Load 0.5 A.
Current:	Max. 5 A. The voltages are measured at a current load of 0.5 A.
Supply:	230 V AC, 50 Hz.
Size:	185 x 225 x 118 mm.
Mass:	2.8 kg.

3618.50 Power supply 24 V AC/DC



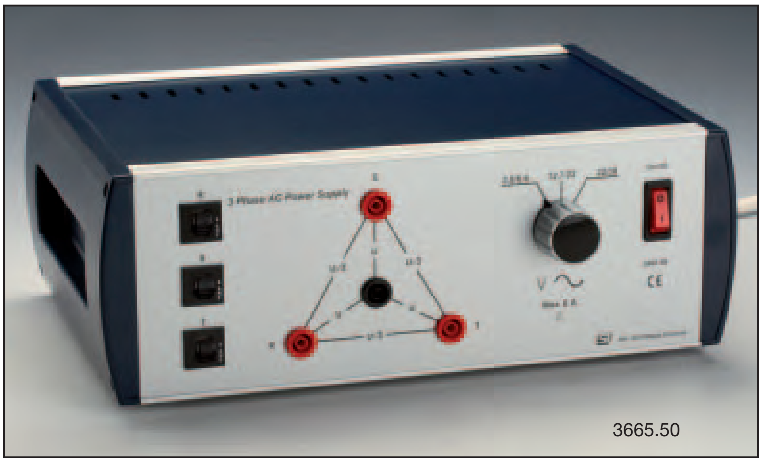
Three-phase power supply

This is the number one choice for experiments with three-phase motors, transformers and electrical distribution systems. The front panel shows the neutral line in the center. Star and delta connections are shown. The star point is fully loadable.

Three sets of voltages between 0 and the phase and
phase/phase are as follows: 3.8/6 - 12.7/22 or 22/38 V max. 6 A. All outputs are protected agianst overload by means of thermally activated circuit breakers.

Supply: 3 x 380 V, neutral and ground.
Size: 297 x 225 x 118 mm.
Mass: 9.1 kg.

3665.50 Three-phase power supply



3665.50

Three-phase power supply

This supply is like 3665.50 except that the voltages between 0 and the phase and phase/phase are as follows: 3.8/6.6 - 9.1/15.8 and 14.4/25 V max. 6 A.

3665.55 Three-phase power supply

	DC							AC					
Type	Voltage V	Current A	Ripple	Stabilized	Adjustment V	A	Protection	Voltage	Current	Adjustment	Protection	Dim. mm	Weight kg
3610.50	1 – 12	6	100%	no	12 steps	no	thermal*	1 – 12	6	12 steps	thermal*	203x225x118	3.1
3610.60	2 – 24	5	100%	no	12 steps	no	thermal*	2 – 24	5	12 steps	thermal*	203x225x118	3.3
3618.50	0 – 21	5	100%	no	continuously	no	thermal*	2 – 24	5	12 steps	thermal*	259x225x118	5.9
	0 – 32	3	4%										
3620.50	0 – 24	10/6	< 25 mV	yes	continuously	yes	electronic	2 – 24	6	12 steps	thermal*	312x225x118	6.9
3620.51	0 – 24	10/6	< 25 mV	yes	continuously	yes	electronic	2 – 24	6	12 steps	thermal*	312x225x118	6.9
3620.60	0 – 24	10/6	< 25 mV	yes	continuously	yes	electronic	0 – 24	6	stepless	thermal*	312x225x118	7.8
3620.62	0 – 24	10/6	< 25 mV	yes	continuously	yes	electronic	0 – 24	6	stepless	thermal*	312x225x118	7.8
3630.00	0 – 24	10/6	<25 mV	yes	continuously	yes	electronic	0 – 24	6	stepless	electronic	312x225x118	2.5
3655.60	-50-0-+500	50 mA	<0,1%	no	continuously	no	electronic	2 – 7	3	6 steps	thermal*	312x225x118	4,6
3655.65	-50-0-+500	20 mA	<0,1%	no	continuously	no	electronic	2 – 7	3	6 steps	thermal*	312x225x118	4,6
3660.50	3K-0–3K	1.8/0.1	<0,1%	no	continuously	no	electronic	6.3	3	no	fuse	312x225x118	4.8

Thermal* = automatic thermal cut-out. Automatically activated in case of overload. Wait approx. 40 s then press the button and continue.

Power supplies for permanent installation

The following power supplies are designed for permanent installation in cabinets, desks, lecterns or student workplaces. Fixtures and installation instructions are provided.

Power supply 0-24 V AC/DC

As 3630.00 but for cabinet/desk installation

3630.22 Power supply 0-24 V AC/DC for permanent installation

Power supply 0-500 V DC

As 3655.65 but for cabinet/desk installation

3655.70 Power supply 0-500 V DC for permanent installation

Power supply 0-6 kV DC

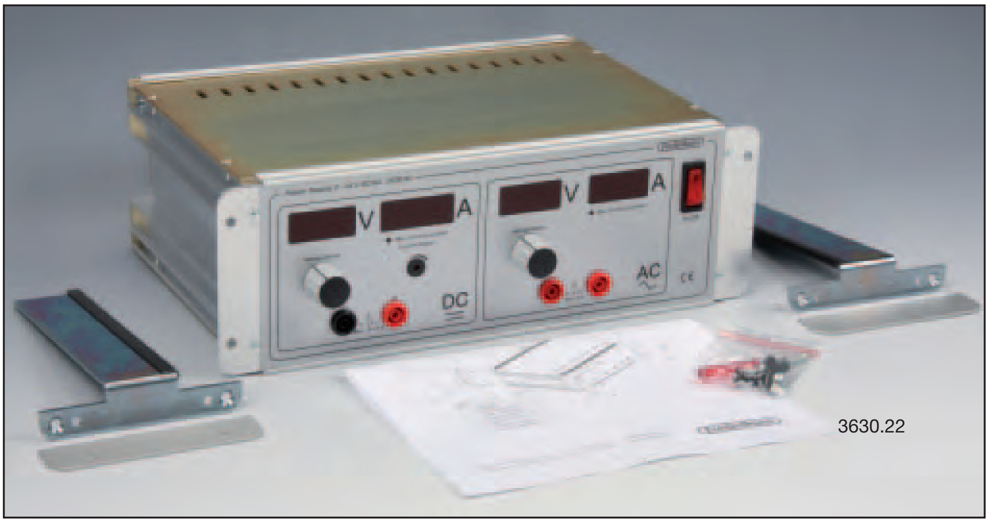
As 3660.50 but for cabinet/desk installation

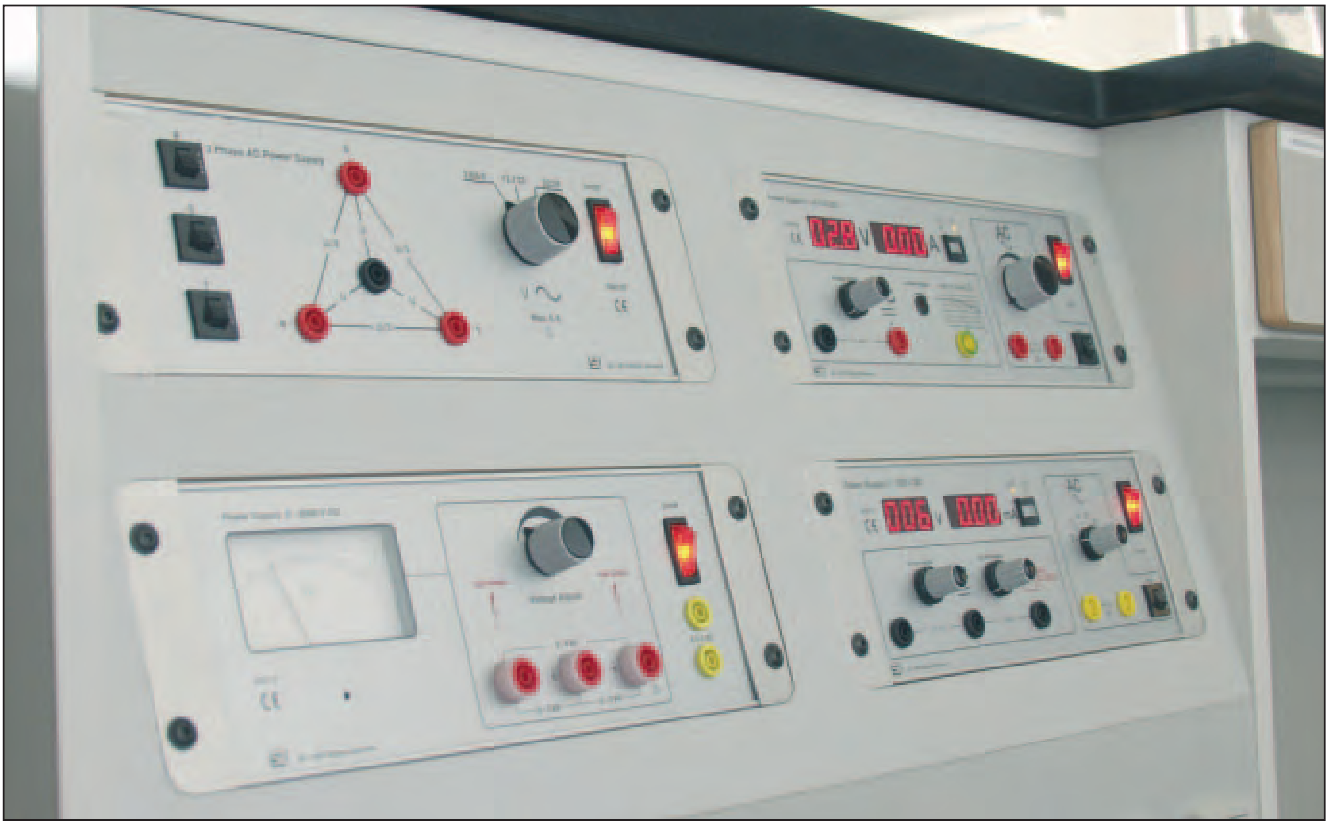
3660.55 Power supply 0-6 kV DC for permanent installation

Power supply three phase AC

As 3665.55 but for cabinet/desk installation

3620.65 Power supply three phase AC for permanent installation


3630.22



3550.20
3550.10

Power supply 9 V DC

Output: 9 VDC, 180 mA. Suitable for GM counter: 5135.30; 5135.35.

3550.10 Power supply 9 V DC

Power supply, switch mode, 3-12 V DC

This compact, switch mode line adapter technology ensures high efficiency and a minimum of heat dissipation. A switch permits selection of the following voltages: 3V/1.5A - 4.5V/1.5A - 6V/1.5A - 7.5V/1.2 A - 9V/1A - 12V/0.75A. Supplied with eight different reversible power connectors.

3550.20 Power supply, 3-12 V

Hand powered generator

The generator is mounted in a transparent plastic housing. Using a hand swing and a gearbox the generator can yield a power output of up to 7.5 watts. The generator unit is supplied with an E10 socket for small bulbs and leads with mini alligator clips for attachment to electrolysis experiments, measuring instruments, electrical circuits, etc. The set consists of two hand generator units and includes complete user instructions.

4716.10 Hand powered generator, set of 2

Power supply 12 V DC

12 V ½ A, fits Manometer 1770.00 and Student Timer 2002.60.

3550.15 Power supply 12 V DC

Battery holder on plate

Battery Holder for one ”D”-cell. Mounted on plate which are fitted with safety sockets.

3521.10 Battery holder on plate

Analog student instruments

3810.60

3810.70

3810.80

Measuring instruments for student use

These instruments are rugged with simple, easily read scales. The instruments are electronically protected and can tolerate accidental overloading. Supplied with safety jack connectors.

Voltmeter

For AC and DC measurements.
Accuracy ±2% at full scale deflection
Resistance 10 kΩ/V
Electronic shielding.
With color coded 4 mm safety terminals.
Ranges: 0-3 V, 0-15 V, 0-30 V, AC or DC
Dimensions: 173 x 108 x 56 mm

3810.60 Voltmeter

Ammeter

For AC and DC measurements.
Accuracy ±2% at f.s.d.
Electronic shielding up to 15 A on all ranges (momentary up to 30 A)
Ranges: 0-0.05 A, 0-0.5 A, 0-5 A AC or DC.
Dimensions: 173 x 108 x 56 mm

3810.70 Ammeter

Galvanometer

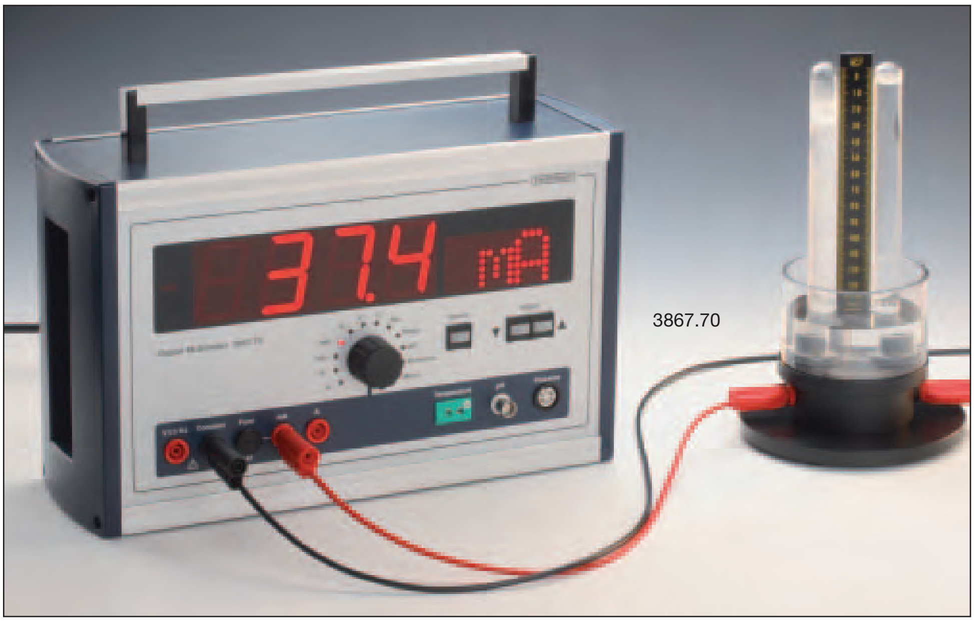
A center zero moving coil galvanometer.
A "push-to-read" switch protects the galvanometer during hookup by shunting the current through an equivalent resistor.
Range: 50 - 0 - 50 µA DC
500 - 0 - 500 µA DC
5 - 0 - 5 mA DC
Dimensions: 173 x 108 x 56 mm

3810.80 Galvanometer

Demonstration multimeter

Manometer · pH-meter · thermometer · multimeter

To maintain maximum student interest in a demonstration requires student involvement.
This new Demonstration Multimeter ensures student interest by allowing the students, no matter where they are in the class room, to see the instrument readings first hand.
Your students no longer have to just take your word for it, they can see the readings themselves.
Designed especially for education, this Demonstration Multimeter has eight very significant features.



1. Extra large (45 mm high) digits
And since the digits are LEDs (Light Emitting Diodes) they can easily be seen from the back of the classroom (up to 8 meters).

2. Extra large units symbols
The units symbols (hPa, V, pH, °C, A, Ω and Hz) ensuring that no student is confused as to what is being measured. A bright 30 mm LED matrix makes this possible. Switching functions automatically set the correct units symbol.

3. Autoranging
The measuring range is automatically matched to the measured value.

4. One instrument for both chemistry and physics
This particular instrument will be used day after day since it not only measures the usual electronic quantities such as volts, amps and ohms, but it also measures pressure Hz/pH and temperature from minus 50 to plus 1200 degrees Celsius.

5. Back facing teacher's display
In most cases the teacher stands behind the measuring instrument, making the reading af the display somewhat awkward. A second display is available for the back of the instrument. Its 14 mm high digits ensure that the teacher can read the value even when a few meters away from the instrument.

6. Computer Output
An RS 232 C output makes it a simple matter to connect your computer to the experiment. The output is optically isolated from the instrument input so there is no danger of damaging the computer when working with high voltages. Since the output is controlled by a microprocessor, using standard data formats, connection to a computer is straightforward.

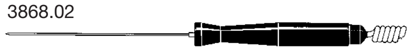
8. Graphing program available
For those cases where it is desirable to plot a function versus time (such as temperature during a chemical reaction) a program is available to take measurement at specific time intervals and then plot the points on a graph. This graph may also be plotted on a printer.

3867.70 Demonstration multimeter.

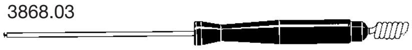
Range	Input range	Accuracy	Input Impedance	
Voltage DC	0 mV – 500 V	0,5% + 1 digit	10 Mohm	
Voltage AC	20 mV – 500 V	10 Hz – 1 KHz 1% + 1 digit 1 Hz – 2 KHz 2% + 2 digit 2 Hz – 5 KHz 5% + 2 digit 5 Hz – 10 KHz 10% + 2 digit	10 Mohm	
Current DC	0 – 10 A	0,5% + 1 digit	10 ohm, 0,1 ohm, 0,01 ohm	Fuse: mA: 2 A Fuse, A: warning
Current AC	20 uA – 10 A	10 Hz – 10 KHz 1% + 2 digit	10 ohm, 0,1 ohm, 0,01 ohm	Fuse: mA: 2 A Fuse, A: warning
Resistance	0 ohm – 10 Mohm	1% + 1 digit		Measuring current: 10 mA – 3 A
Frequency	1 V + / 5 V +	0,5 % + 1 digit	10 Mohm	1 Hz – 200 KHz
Temperature	- 200 C – 1370 C	0,1% + 1 digit		Probes: NiCr-Ni type K
Pressure	0 – 7000 hPa	0,1% + 1 digit		Connector: DIN
pH	0,00 – 14,00 pH – 1800 mV – + 1800 mV	0,1% + 1 digit	> 10 Gohm	BNC

Accessories:

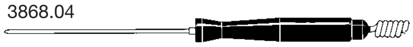
3868.02



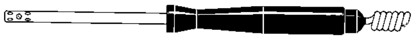
3868.03



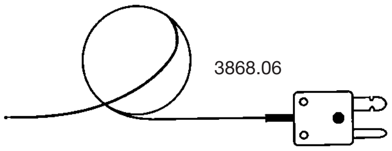
3868.04



3868.05



5415.20



3868.06

IM-131410
Air pressure sensor
Range: 0 to 1300 hPa.
IM-131510

Accessories for demonstration multimeter

Thermo probe –type K NiCr-Ni probes

No	Type	Probe dimension	Max Temp.	Material	Time constant*
3868.01	Immersion probe	150 x Ø 3 mm	+1200 °C	Highly fireproof steel	1,3 s
3868.02	Immersion probe	150 x Ø 1,5 mm	+1200 °C	Highly fireproof steel	1,5 s
3868.03	Immersion probe	197 x Ø 3 mm	+1200 °C	Highly fireproof steel	1,5 s
3868.04	Surface probe	150 x Ø 4 mm	+500 °C	Highly fireproof steel	0,95 s
3868.05	Air probe	185 x Ø 6 mm	+250 °C	Highly fireproof steel	0,5 s
2606.53	Thread probe	120 cm long	+200 °C	Highly fireproof steel	

*By time constant means the time by which the probe will register 63,2 % of full reading.

pH-electrode:

No	Type	Probe dimension	Range	Socket
5415.20	Combi-electrode	150 x Ø 12 mm	0,0-14,0 pH	BNC-plug

Pressure sensors:

No	Range	Socket	Piping size
IM-131410	0-130 kPa	DIN	Ø6mm
IM-131510	50-700 kPa	DIN	Ø6mm

Watt and energy meter

Our Watt and Energy Meter is a most versatile instrument which apart from measuring voltage and current is capable of measuring apparent power (VA), phase angle (φ), active power (W), energy con-sumption (WS, Wh), frequency (Hz), and time elapsed (s/h) for energy consumption. Voltage and current measured are true RMS-values.

The Watt and Energy Meter is microprocessorcontrolled and a number of the values mentioned above are calculated by means of the integral software.

The input terminals on the front panel may be used for low voltage measurings. The instrument is also equipped with input terminals on the rear panel which makes it possible to take true-life measurements from the mains net. E.g. measuring the power consumption of electric household articles.

The instrument is equipped with automatic change of measuring range, and automatic change between measurings on input from either the front or the rear panel sockets.

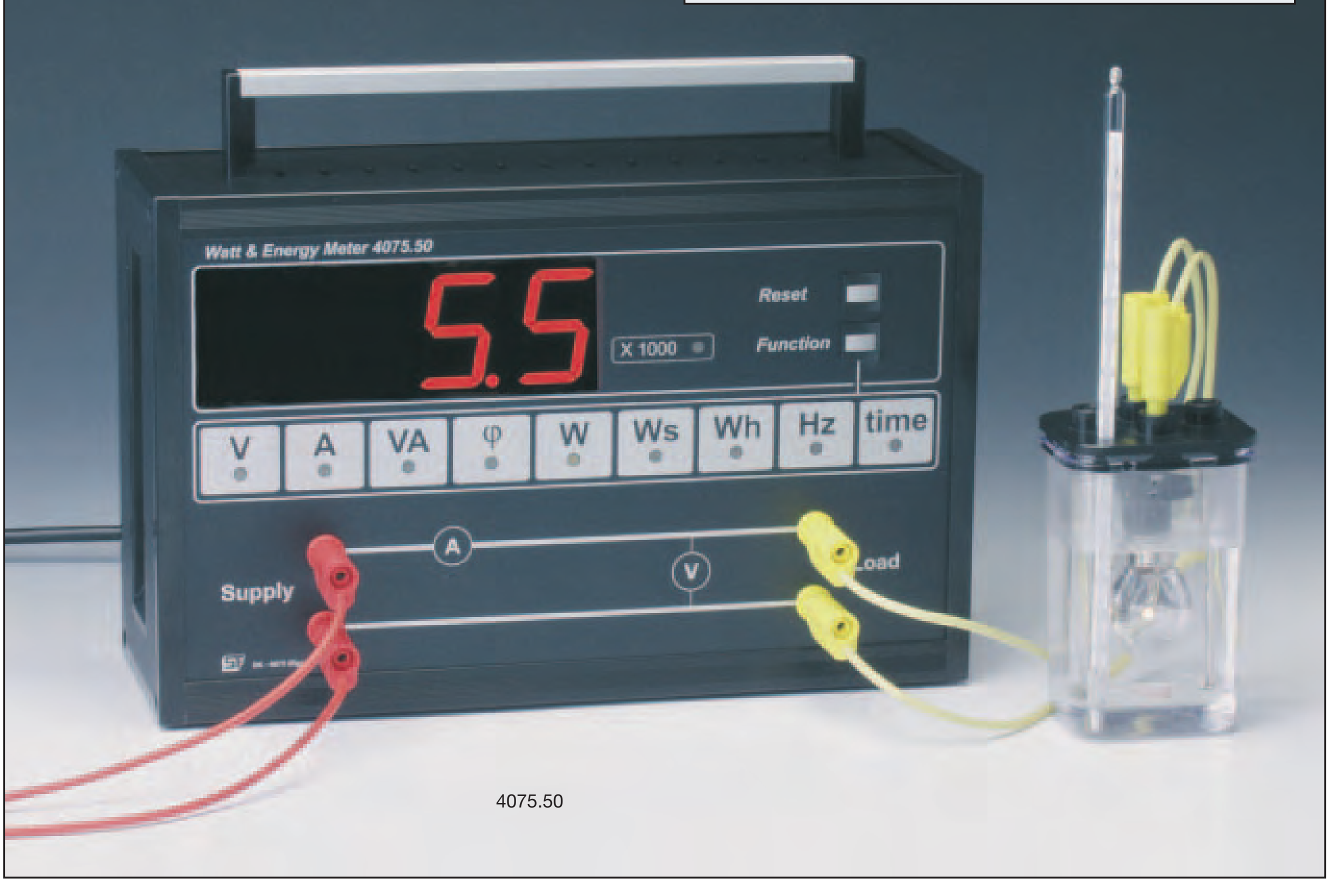
Display:

The Watt and Energy Meter is designed for educational purposes, and is for this very reason equipped with a 4 segment LED display with 45 mm high digit easily seen even from the back of the class-room.

4075.50 Watt and energy meter

Graf REC MON STOP Datalyse **Compatible**

Supply
A
V
Load



4075.50

Facilities for Watt and energy meter:

Computerinterface:

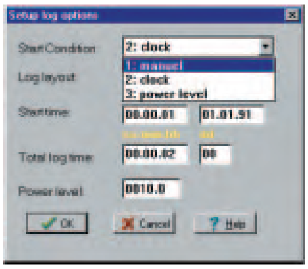
The instrument is equipped with a RS232C serial interface which makes it a simple matter to connect it to a computer. The meter's "built-in" software makes it possible to control and read all measured and calculated parameters through the interface.
The "language" returned is selectable.

Graphing program available

For those cases where it is desirable to plot a function versus time (such as power during a phycical experiment) a program is available to take measurement at specific time intervals and then plot the points on a graph. This graph may also be plotted on a printer.

Datalogging:

As an optional extra, a datalogging function is available. Logging can be initiated by setting a start condition either at a fixed time or power level. Setting and reading is done through the interface.



Start Condition: 2: clock
1: manuel
2: clock
3: power level
Log layout
Start time: 00.00.01 01.01.91
Total log time: 00.00.02 00
Power level: 0010.0

Setting up the logging facility of the Watt- and Energymeter.

Technical specifications:

Range	Range	Solution	Ri	Accuracy	Frequency
V (Front Panel)	0-240 V RMS	0,1 og 1 V RMS	1 MΩ	±(2,5% + 1dgt.)	0-1000
A (Front Panel)	0-10 A RMS	0,01 og 0,1 A RMS	0,047 Ω	±(2,5% + 1dgt.)	0-1000
VA	0-2400 VA	0,1 og 1 VA		±(5,0% + 1dgt.)	
φ	0°-±90°	1°		±(5% + 2dgts)	3-1000
W	0-2400 W	0,1 og 1 W		±(5% + 1dgt.)	
Ws/Wh	0,1-10000 Ws/Wh	0,1 og 1 Ws/Wh		±(5% + 1dgt.)	
Time	0,1-10000 x 103s/h	0,1 og 1 s/h		±(0,2 + 1dgt.)	
Hz					3-1000
V (Rear Panel)	30-240 V RMS	1 V RMS		±(2,5 + 1dgt.)	45-65
A (Rear Panel)	0-10 A RMS	0,01 og 0,1 A RMS		±(2,5 + 1dgt.)	45-65

Watt meter

This robust, user-friendly instrument is easy for the students to understand. It can measure both AC and DC power. The instrument is overload-protected and will tolerate brief episodes of incorrect connection and overload. Supplied with 4 mm safety jack connectors and a 4 digit LCD.

Power supply:	4 ea. 1.5 V AA batteries or line adapter 3550.10 or 3550.20
Measuring range:	0-200 W (max. 30 V and max. 10 A)
Size:	158 x 108 x 56 mm

4065.50 Watt meter

Wattmeter 4065.50
-00.0
0 - 200 Watt
V
A
CE

4065.50

Digital autorange multimeter, model 125

This analog bar graph and digital instrument measures voltage, current, resistance and a diode tester with optional sound signal. The “auto power off” feature turns off the power after about 10 minutes. There is a “battery low” indicator.
The instrument is provided with an automatic sound signal in case of incorrect connection to limit the risk of damage. Manual or automatic scale switching is provided along with automatic polarity and over range indicators.

Technical Specifications

Display: 3½ digit LCD.
Analog bar graph: 34 segments.
DC voltage ranges: 0.320/3.2/32/320/600V +/-(1.2% + 1 LSD).
AC voltage ranges: 3.2/32/320/600V +/-(2.0% + 4 LSD).
Input impedance: >10 M ohm.
DC current: 0.320/3.2/320 mA, 10A +/-(3% + 3 LSD).
AC current: 0.320/3.2/320 mA, 10A +/-(3.5% + 3 LSD).
Resistance: 320/3.2k/32k/3.2M/32M ohm +/-(1.5-5% + 5 LSD).
Power supply: 9V block battery.
Size: 147 x 70 x 39 mm.
Mass: 390 g incl. protective cover.
LCD = liquid crystal display
LSD = least significant digit
Supplied complete with measuring leads, instructions, protective cover and battery.

3862.15 Digital autorange multimeter

Digital multimeter, model 120

This is a user-friendly, inexpensive multimeter. With only two jack connections the risk of incorrect operation is reduced. The instrument can measure DC voltages and currents, AC voltage and resistance. Diode test, transistor test and battery test features are provided.

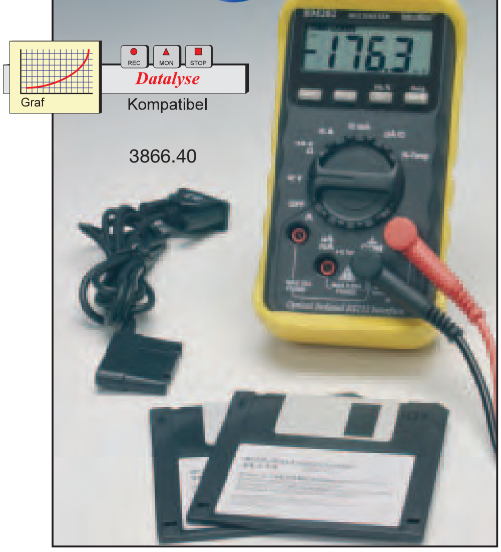
Technical Specifications

Display: 3½ digit LCD
DC voltage ranges: 2/20/200/600V +/-(1.2% + 1 LSD)
AC voltage ranges: 200/500V +/-(2.0% + 4 LSD)
Input impedance: >10 M ohm
DC current: 2A +/-(2.5% + 3 LSD)
Resistance: 0.2/2/20/200/2000 kiloohm +/-(1.5% + 3 LSD)
Power supply: 9V block battery
Size: 147 x 70 x 39 mm
Mass: 390 g incl. protective cover
Supplied complete with measuring leads, instructions, protective cover and battery.

3862.25 Digital multimeter model 120

3862.25

3862.15



3866.40

Multimeter – Elma 202 w/ Windows software

Multimeter measuring current, voltage, resistance, audible continuity test, frequency, capacitance, temperature (adapter sold separately).

Optional manual/auto range, relative measurements and datahold. Built-in wireless detector for determining electric fields from computer displays etc. Also suitable as wireless pole finder. Communicates with PC’s at 4 Hz making data logging and graphical visualization an option.. Compatible with the Datalyse software. Elma 202 is a sturdy instrument well suited for the educational purposes. Supplied with software (Windows), cables and rubber case.

3866.40 Multimeter
3866.41 Adapter for type K temperature probe

Oscilloscope 20 MHz

This user-friendly and inexpensive model is well-suited to use in schools. The technical specifications are as follows:

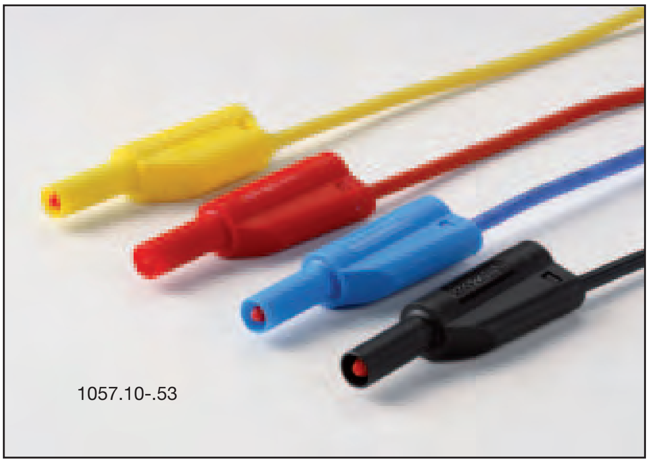
- Double trace with XY-option
- Band width 20 MHz
- Sensitivity 5 mV
- Sweep rates 0.5 s to 50 ns per cm
- Supplied with BNC connections with separate grounds
- Trigger connection

4000.40 Oscilloscope 20 MHz

Safety cables

Safety cables are test cables with 4 mm plugs and a firm shielding. Safety cords cannot be plugged into regular socket outlets. Also the live parts cannot be touched by hands. Manufactured to IEC 61010. Highly flexible silicone shielded safety cords with copper area 1,5 mm^2 max 1000 V / 25 A, temperature range -60-180 °C.

Item no	Name	Length	Color
1057.10	Safety cord	25 cm	black
1057.11	Safety cord	25 cm	red
1057.12	Safety cord	25 cm	yellow
1057.13	Safety cord	25 cm	blue
1057.20	Safety cord	50 cm	black
1057.21	Safety cord	50 cm	red
1057.22	Safety cord	50 cm	yellow
1057.23	Safety cord	50 cm	blue
1057.40	Safety cord	100 cm	black
1057.41	Safety cord	100 cm	red
1057.42	Safety cord	100 cm	yellow
1057.43	Safety cord	100 cm	blue
1057.50	Safety cord	200 cm	black
1057.51	Safety cord	200 cm	red
1057.52	Safety cord	200 cm	yellow
1057.53	Safety cord	200 cm	blue



BNC/double banana plug

Item. no.	Name
1110.05	Adapter BNC/double banana plug, safety type

Alligator clips, safety type

Item. no.	Name	Color
1090.20	Alligator Clip	black
1090.21	Alligator Clip	red

1090.20-.21
1110.05

Alligator clips

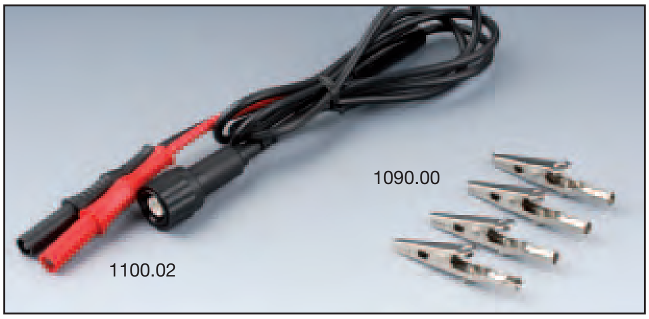
Un-shielded. With 4 mm hole. Fits both standard test cables and safety type test cables. Package with 50 pcs.

1090.00 Alligator Clips

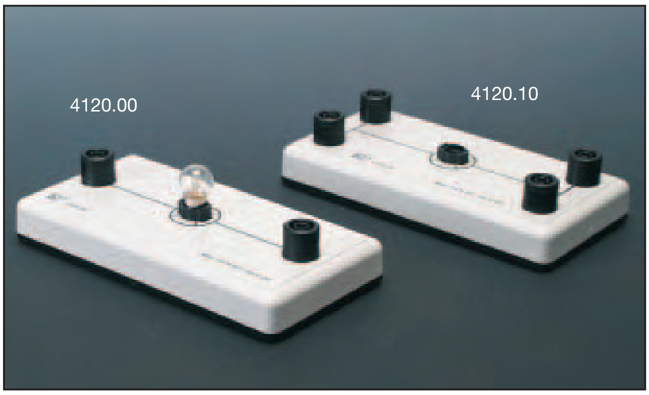
Shielded cable

Length 115 cm. BNC-plug and safety type banana plug. Impedance 50 ohm.

1100.02 Shielded cable



Lamp holders and switches



Lamp holder E 10 (M.E.S.)

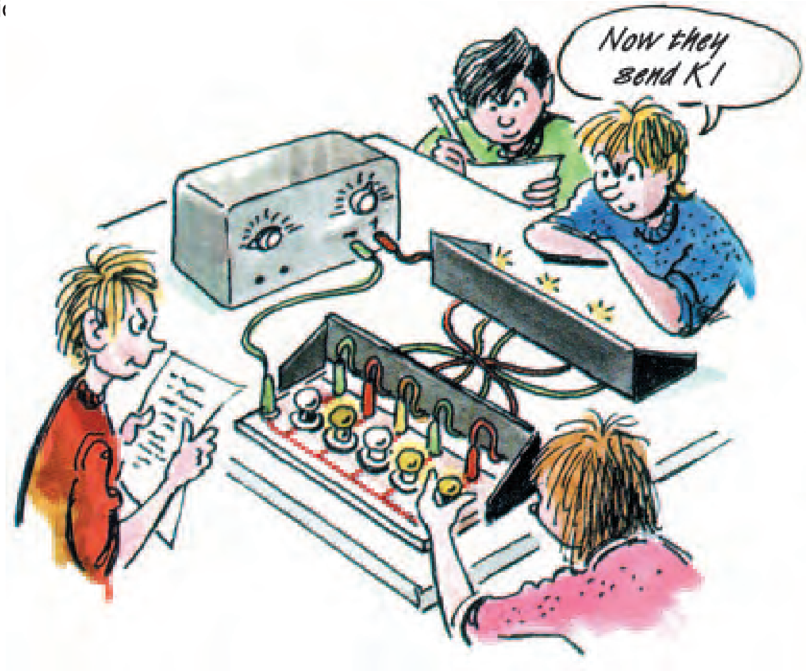
Mounted on a plastic base with two
4 mm safety terminals. Dimensions: 72 x 143 mm.

4120.00 Lamp holder E 10 (M.E.S.)

Lamp holder E 10 (M.E.S.)

Mounted on a plastic base with four 4 mm safety terminals for series or parallel connecti
72 x 143 mm.

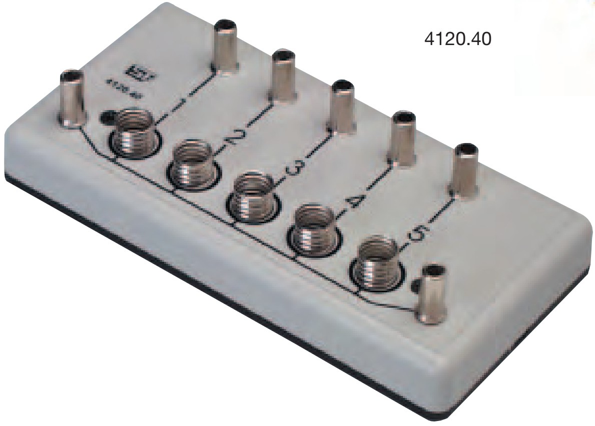
4120.10 Lamp holder E 10 (M.E.S.)

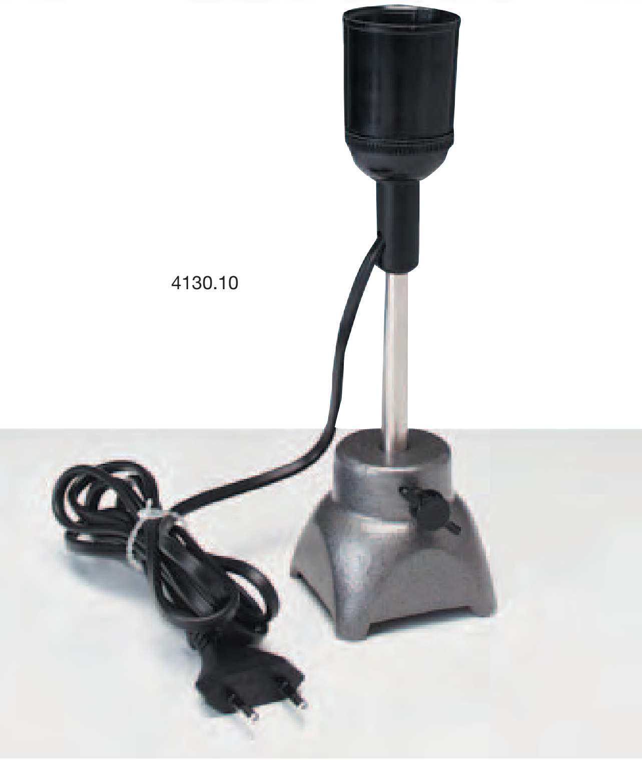

Now they send K!

Lamp sockets, 5 E-10 sockets

This item is useful for demonstrating parallel and series data transmission when used with the 6 lead cable no. 1124.00. 5 E-10 sockets are conveniently mounted on a low plastic box and connected to six 4 mm connectors for safely leads. All of the E-10 socket middle poles are connected together to 4 mm connector number 6.
Size: 72 x 143 mm.

4120.40 Lamp sockets, 5 E-10 sockets





Lamp holder E 27 (ES)

Mounted on a 10 mm diameter rod, supplied with cable and 220 V plug.
Base is not included.

4130.10 Lamp holder E 27 (ES)

Lamp holder, pivot socket

Mounted on an insulated plate with two 4 mm safety terminals on a 10 mm diameter rod. Length 170 mm, distance between poles 40 mm.

4135.10 Lamp holder, pivot socket

Contact key, single

Consists of a nickel-plated spring arm with press knob. Two 4 mm safety terminals. Mounted on a plastic base 72 x 143 mm.

4140.00 Contact key, single

Knife switch

Single pole double throw. Plastic base with three 4 mm safety terminals, 72 x 143 mm.

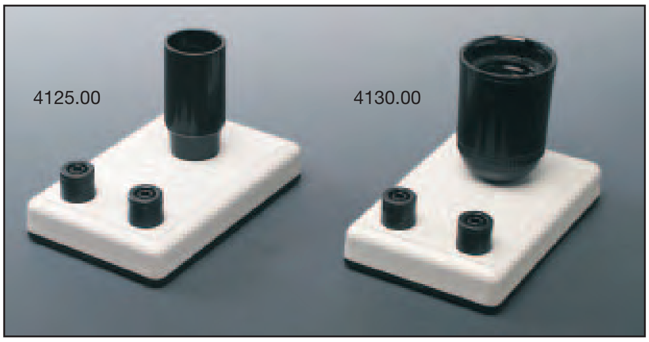
4145.00 Knife switch

4140.00
4145.00
4135.10

Push-button

Mounted on a plastic base with two 4 mm safety terminals. 72 x 112 mm.

4150.00 Push-button



Lamp holder E 14

Mounted on a plastic base with two 4 mm sockets. 72 x 143 mm.

4125.00 Lamp holder E 14

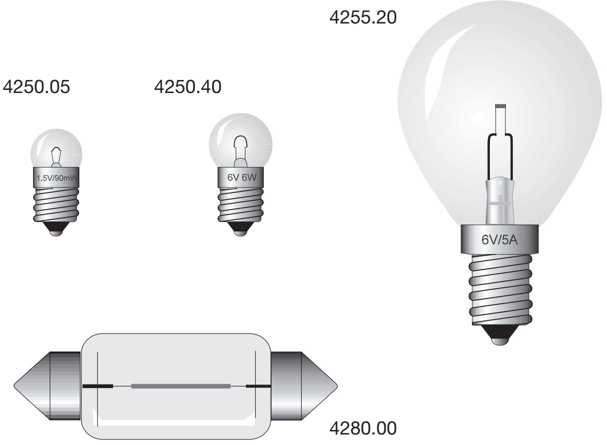
Lamp holder E 27 (ES)

Mounted on a plastic base with two insulated 4 mm sockets. 70 x 140 mm.

4130.00 Lamp holder E 27 (ES)

Lamps

No.	Voltage/current		Socket	Units/ package
4250.05	1,5 V	0,09 A	E10	10
4250.10	2,5 V	0,3 A	E10	10
4250.15	3,5 V	0,2 A	E10	10
4250.20	4 V	0,3 A	E10	10
4250.25	6 V	0,05 A	E10	10
4250.30	6 V	0,1 A	E10	10
4250.35	6 V	0,5 A	E10	10
4250.40	6 V	1 A	E10	10
4250.45	12 V	0,25 A	E10	10
4250.50	24 V	0,2 A	E10	10
4255.20	6 V	5 A	E14	
4280.00	12 V	15 W	pivot	clear

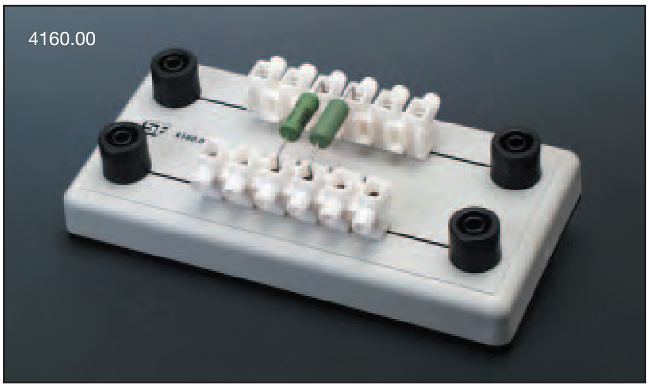


Resistors

Resistor holder

Two lines of screw terminals are mounted on a plate and supplied with 4 safety terminals. They are used for mounting resistors to provide combinations of resistance values. Size: 72 x 143 mm.

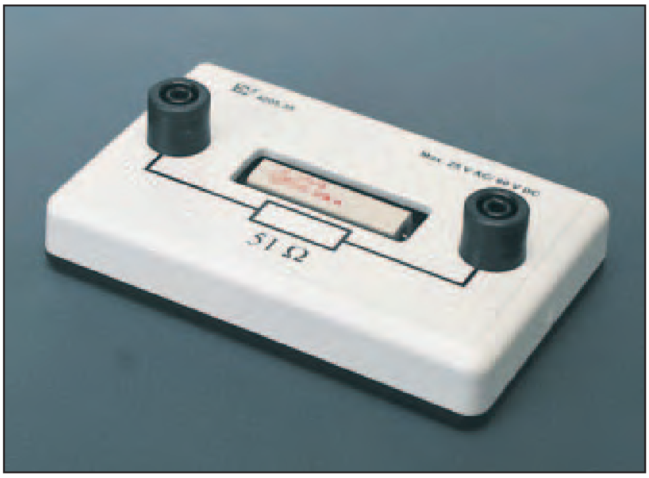
4160.00 Resistor holder on plate



Electrical resistance

Resistance wire wound on ceramic poles and mounted on a plastic base with two 4 mm safety terminals.
72 x 112 mm.

No.	Resistance	Watt
4205.05	1 Ω	40 W
4205.10	2 Ω	40 W
4205.15	3 Ω	40 W
4205.20	4 Ω	40 W
4205.25	5 Ω	40 W
4205.30	10 Ω	40 W
4205.35	51 Ω	9 W
4205.40	100 Ω	9 W
4205.45	150 Ω	9 W
4205.50	1000 Ω	9 W
4205.55	2 kΩ	40 W
4205.60	5 kΩ	10 W
4205.65	10 kΩ	40 W



9 W resisitor.

40 W resisitor.

Variable resistors

This linear variable resistor is cabinet mounted with safety jack connectors. The resistor inside is wound on a stable ceramic core. There are three safety jack connections on the cabinet, so the resistor can serve as a variable resistor or as a voltage divider. The resistor can be overloaded 100% for a brief period (max. 4 minutes).

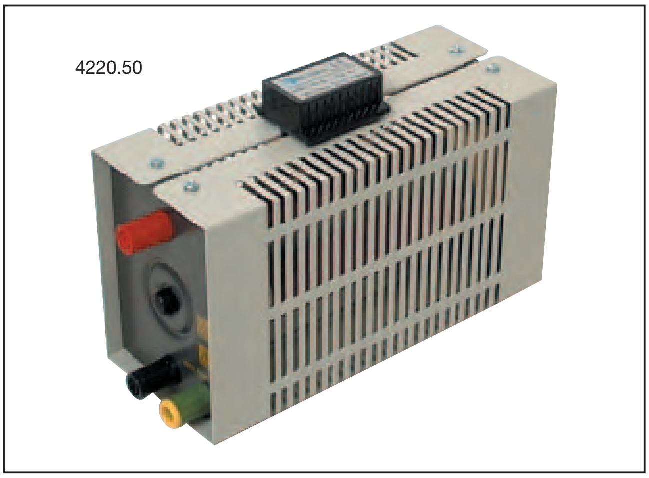
4220.50 Variable resistor, 0-10 Ω/4 A

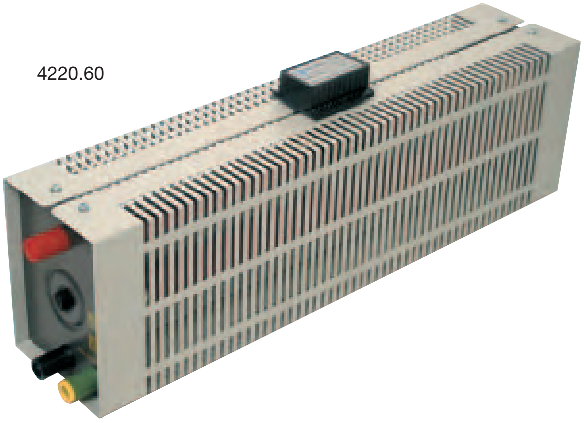
4220.60 Variable resistor, 0-33 Ω/3.1 A

4220.70 Variable resistor, 0-100 Ω/1.8 A

4220.80 Variable resistor, 0-330 Ω/1 A

4220.90 Variable resistor, 0-1000 Ω/0.57 A


4220.50


4220.60

4236.00

2690.00

Decade resistance box 0 to 10 MΩ

This solidly built decade resistance box has 7 decades.
Range: 0 to 9,999,999 ohm at 1 ohm intervals
Accuracy: x 1 ohm and 10 ohm +/-(2% + 0.08 ohm).
X 100 ohm to 10 M ohm +/-(1% + 0.08 ohm).
Size: 280 x 85 x 175 mm.
Mass: 1.3 kg

4236.00 Decade resistance box 10 M Ω/1 Ω

Decade resistance box 0 to 1 MΩ

This solidly built decade resistance box has 7 decades.
Range: 0 to 999.999 ohm at 0.1 ohm intervals
Accuracy: x 0.1 ohm +/-(5% + 0.04 ohm).
x 1 ohm and 10 ohm +/-(2% + 0.04 ohm).
x 100 ohm to 100 Kohm
+/-(1% + 0.04 ohm).
Size: 280 x 85 x 175 mm.
Mass: 1.3 kg

4236.10 Decade Resistance box 1 M Ω/0,1 Ω

Material samples

Set of 8 sticks. Used to examine the conductivity of different materials. Made of aluminum, lead, nylon, glass, rubber, iron, copper and brass. Supplied with plastic case with transperant cover. Dimension: Diameter 5 mm, length 120 mm.

2690.00 Material samples

Resistors for measuring temperature coefficients

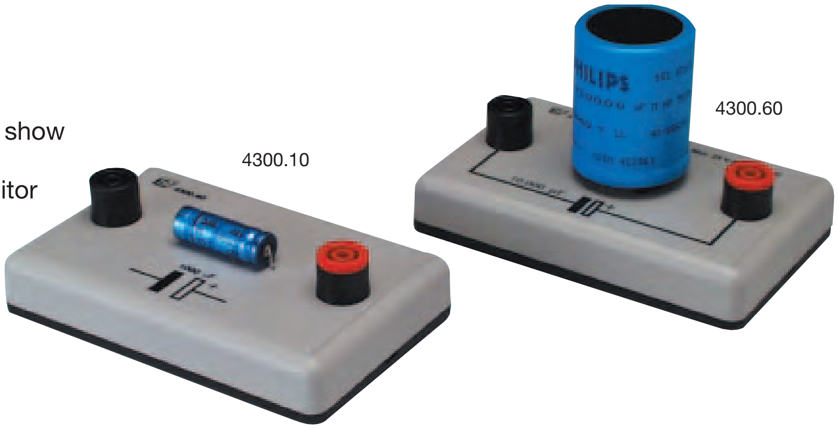
These immersible resistors are used to determine the resistance temperature coefficient for various materials. They consist of resistance wire (diameter 0.25 mm) wound on plexiglass cores with safety jack connectors. The resistance wire is immersed in a non-conductive liquid (e.g. kerosene or mineral oil). By measuring the resistance as a function of temperature the temperature coefficients of the materials can be found. Size 180 mm x 20 mm diameter.
The specified resistance values are for 20 °C.

4240.10 Resistor, copper app. 1.8 Ω
4240.20 Resistor, constantin app. 46.7 Ω
4240.30 Resistor, nickel app. 8.7 Ω

Capacitors

Electrolytic capacitors

Used in energy conversion experiments to show how energy is stored in a capacitor and to demonstrate that energy stored in a capacitor is proportional to V^2.



No.	Description			
4300.10	Capacitor	1	µF	63 V
4300.20	Capacitor	10	µF	25 V
4300.30	Capacitor	100	µF	16 V
4300.40	Capacitor	1.000	µF	16 V
4300.50	Capacitor	4.700	µF	25 V
4300.60	Capacitor	10.000	µF	40 V
4300.70	Capacitor	15.000	µF	25 V

Metal plates with insulating handles

For use with EHT supply or Van de Graff generators to form a simple parallel plate capacitor. Anodized aluminium disc 150 mm diameter, mounted on insulating plastic rod 10 mm diameter, with 4 mm diameter contact holes.

4315.10 Metal plates with insulating handles

REQUIRED ACCESSORIES:
3660.50 High voltage supply or 3700.50 band generator.
2946.00 Profil track.
2946.10 Track riders, 2 ea.
0080.60 Retort stand rods, 2 ea.
0028.00 Bosshead Ø 10 mm, 2 ea.

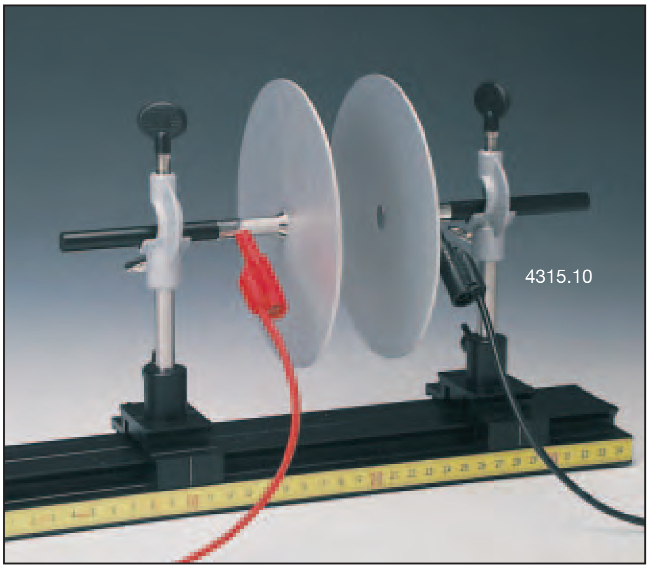
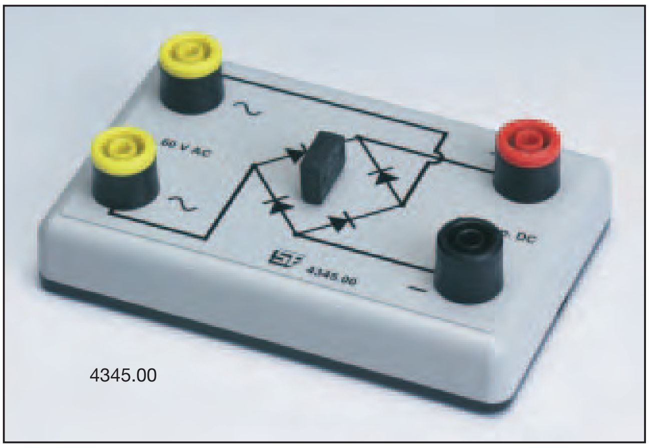


Plate capacitor

This square plate capacitor is manufactured from an aluminum plate with a right angle bend at one end. This edge has a slot to facilitate mounting on high voltage support connectors.
Plate size: 220 x 220 mm, area: 484 cm^2.

4315.30 Plate capacitor, 22 x 22 cm



Full wave bridge

This silicon full wave bridge is mounted on a plate with 4 safety jack connectors. Max. 1.2 A / 60 V AC.
Plate size: 72 x 112 mm.

4345.00 Full wave bridge, 1.2 A

Semiconductors

Rectifier

This silicon diode is mounted on a plate with safety jack connectors. Max. 6A/600 V AC. Plate size: 72 x 112 mm.

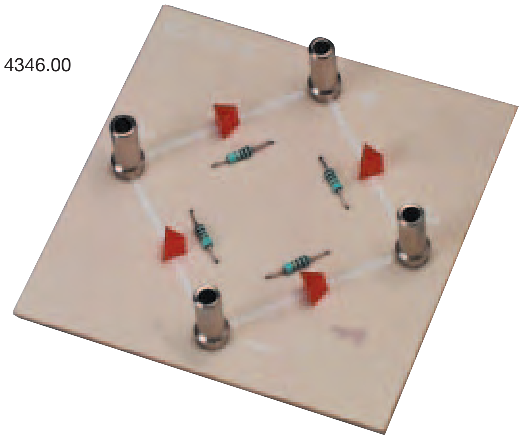
4340.00 Rectifier

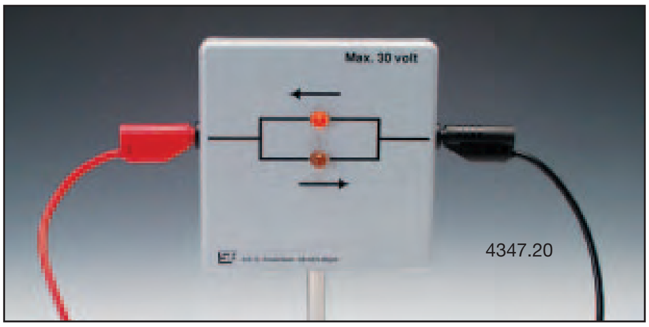
4340.00
Max. 25 V AC/ 60 V DC
Max. 6 A
4340.00

Full wave bridge with LED’s

This item is used for demonstrating the operation of a full wave bridge. It gives a good, intuitive illustration. It consists of a plate with four arrow shaped, red LED’s mounted on it and connected to four safety jack connectors. The unit is protected against overloads by current limiting resistors. Max 15 mA/25 V AC.
It can be used with signal generator type 2500.50. By reducing the frequency each step in the rectification process can be followed. Plate size: 90 x 90 mm.

4346.00 Full wave bridge with LED’s

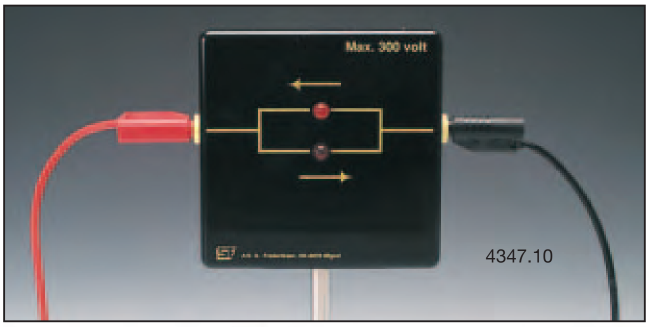




Current direction indicator, 30 V

This current direction indicator has LED's mounted with opposite polarities. If the unit is connected to a direct current source, then one of the LED's will light up and show the direction of the current. If the unit is connected to an alternating current source, the both LED's will light up. If the unit is moved back and forth the eye can detect that the LED's light up alternately as the current switches back and forth. The current indicator is supplied with two 8 mm diameter yellow LED's mounted in a cabinet with 4 mm safety connectors. It is provided with a 10 mm diameter mounting rod. Size: 120 x 120 x 27 mm.
Rod length: 93 mm.

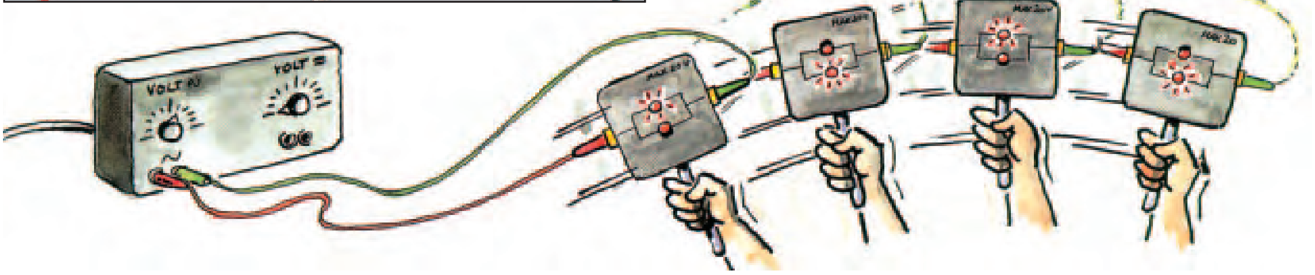
4347.20 Current direction indicator, 30 V



Current direction indicator, 300 V

As item no. 4372.20 but with red LED's for connecting to voltages of up to 300 V.

4347.10 Current direction indicator, 300 V



Stationary terminals and insulators

Stationary terminal

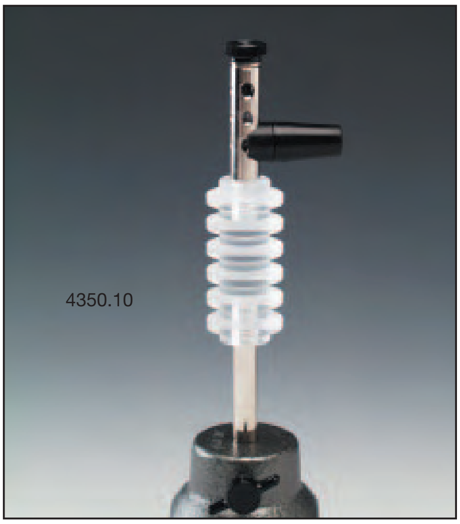
10 mm dia. rod with insulated terminal screw and two 4 mm dia. mounting holes for 4 mm plugs.
Length 100 mm.
Supplied in pairs.

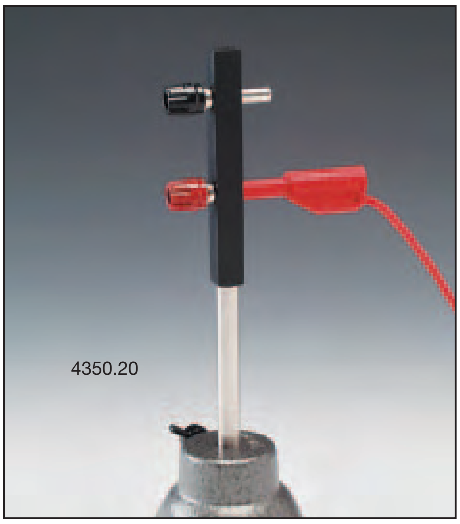
4350.00 Stationary terminal

Stationary terminal, insulated, pair

Insulated stationary Terminals with Ø10 mm mounting rod. Fitted with an insulated terminal screw. Fits all 4-mm banana plugs. Supplied in pair.

4350.30 Stationary terminal, insulated, pair





Insulator

Insulated holder for electric cables. Plexiglass insulator on rod with 4 and 4.5 mm mounting holes and terminal screw. Length 170 mm.

4350.10 Insulator

Insulator

Insulator on 10 mm dia. rod with terminal screws.
Length 200 mm.

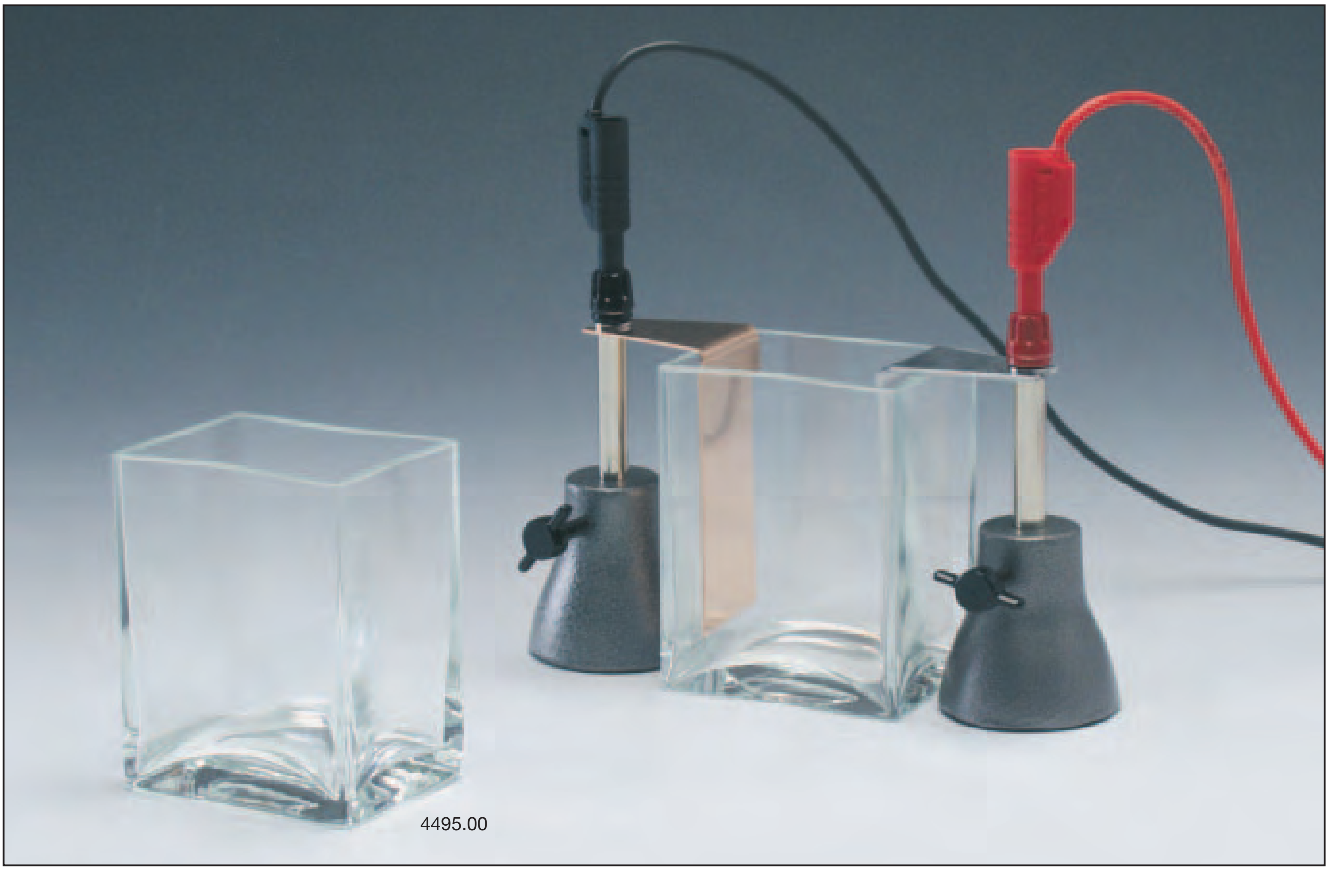
4350.20 Insulator

Electric cells

Glass jar

Sturdy Glass Jar for making up simple cells. Dimensions: 80 x 60 x 100 mm (external). Wall thickness: 4-5 mm. Weight: 420 g.

4495.00 Glass jar



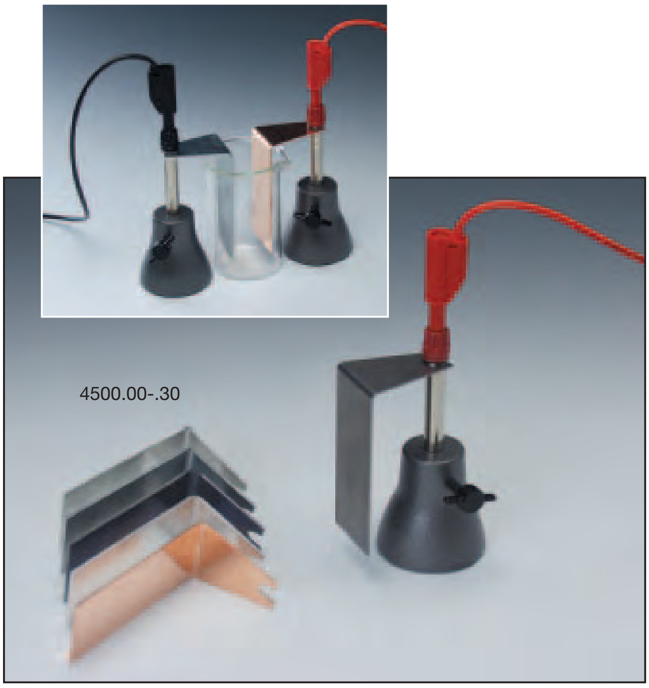
Electrodes

Electrode plates with slit, bend

Electrode Plates designed for mounting in Stationary Terminal no. 4350.00. can be used for making simple cells, using Glass Jar no. 4495.00.

Dimension: 37 x 70 mm.

No.	Metal	Thicknes
4500.00	Cupper	1 mm
4500.05	Aluminum	2 mm
4500.10	Zink	2 mm
4500.20	Lead	2 mm
4500.30	Iron	1 mm

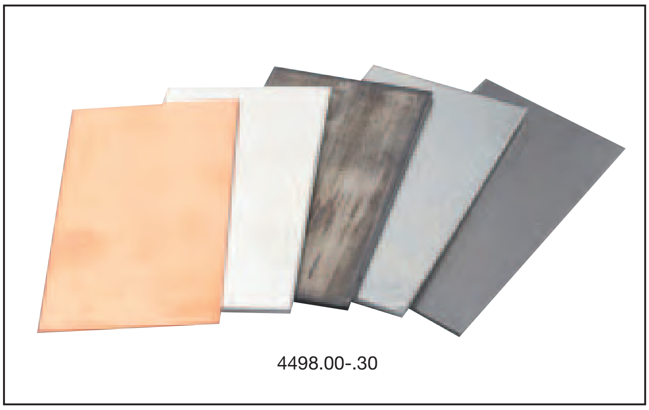


4500.00-.30

Electrode plates

Electrode plates designed for mounting in electrode holder 4515.20. Used for voltaic cells. Dimension: 50 x 87 mm.

Item no.	Electrode	Thicknes
4498.00	Copper	1 mm
4498.05	Aluminum	2 mm
4498.10	Zinc	2 mm
4498.20	Lead	2 mm
4498.30	Iron	1 mm

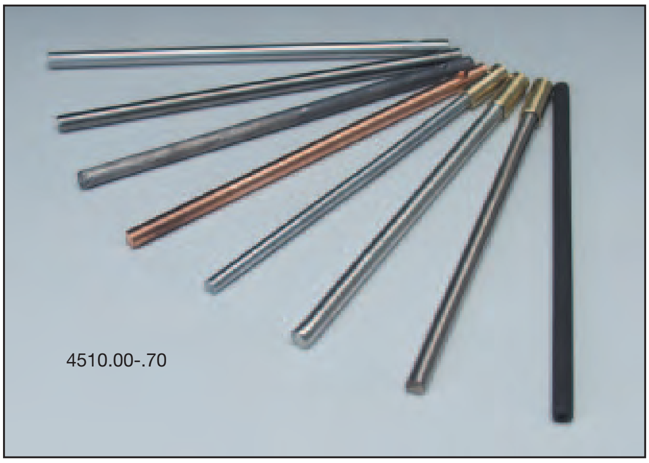


4498.00-.30

Electrodes, round

These round electrodes 6-7 mm in diameter will fit the electrode holders no. 4515.10 and 4515.20 and electrode connector no. 4513.00. They will also fit a standard rubber stopper with a center hole.

Item no.	Electrode	Length
4510.00	Copper	150 mm
4510.10	Nickle	150 mm
4510.20	Aluminum	150 mm
4510.30	Tin	150 mm
4510.40	Iron	150 mm
4510.50	Carbon	app. 200 mm
4510.60	Zink	150 mm
4510.70	Lead	150 mm



4510.00-.70

Electrode holders

Electrode holder, double

Electrode holder for two electrodes. Can be used both with round electrodes (4510.xx) and plate electrodes (4498.XX). The electrode holder is designed to be able to rest on the edge of glass jar 4495.00, or a 250 ml low beaker. Furthermore the electrode holder can be mounted in a retort stand by means of holder no. 0028.00 (not included).

4497.10 Electrode holder, double

Electrode connector

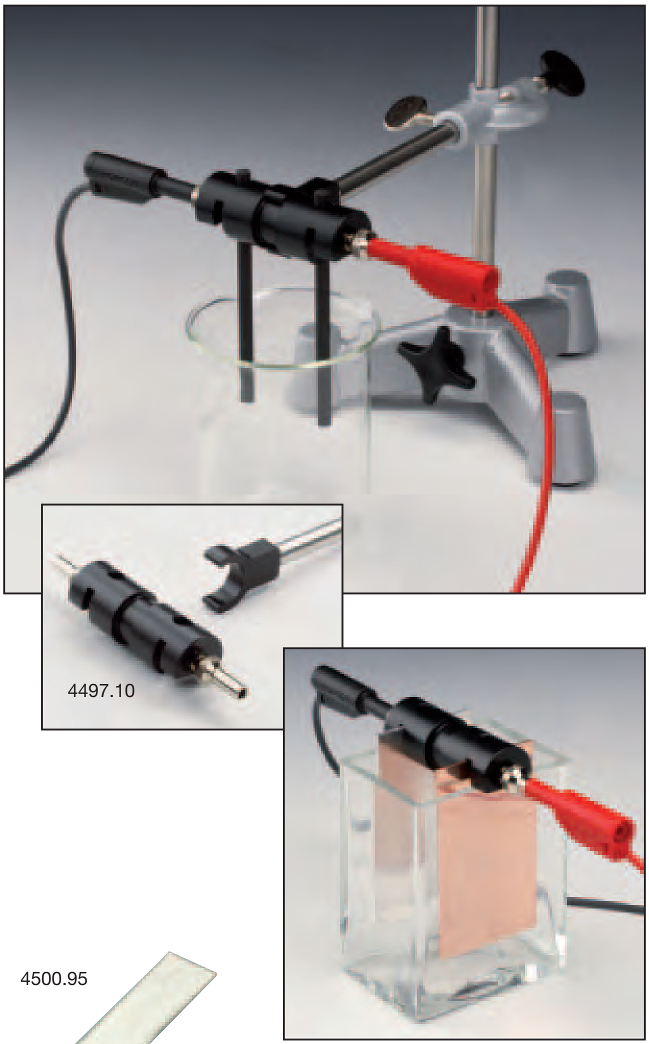
This electrode connector is suitable for round electrodes up to 7.5 mm in diameter. The holder contact screw has a bushing for connecting 4 mm safety jacks. Size: 12 mm x 25 mm diameter. Made of acid resistant plastic.

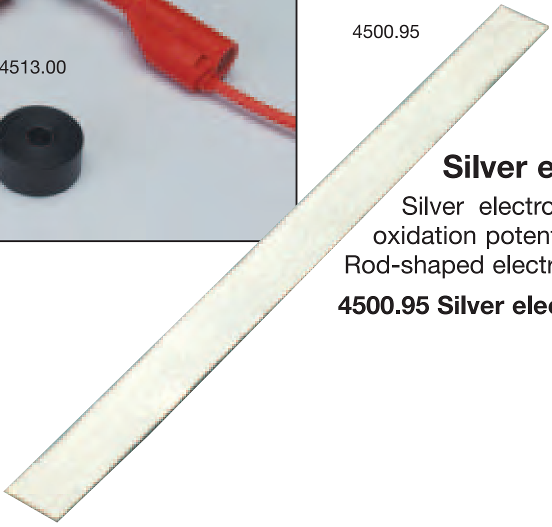
4513.00 Electrode connector

Electrode holder for round electrodes

Holder for round electrodes with a diameter up to 7.5 mm. The holder is designed with a slit, for mounting in Stationary Terminal no. 4350.00. The electrode is kept in position by means of a shrew, which also is supplied with a terminal for safety cables, thus acting as a contact. The Electrode holder is made of acid proof plastic. Dimension: 65 x 25 x 12 mm.

4515.10 Electrode holder for round electrodes

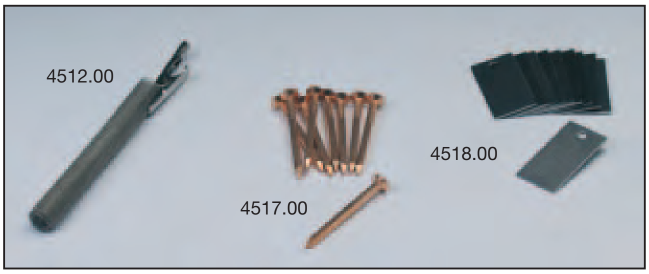




Silver electrode

Silver electrode for experiments concerning the oxidation potential of metals or building voltaic cells. Rod-shaped electrode of dimension 8 x 0.5 x 100 mm.

4500.95 Silver electrode



Nickel net electrode

This nickel net electrode has a large surface area. It is made of nickel netting and is provided with a crocodile clip connector. Size: 100 mm x 10 mm diameter.

4512.00 Nickel net electrode

Copper electrode, copper nails

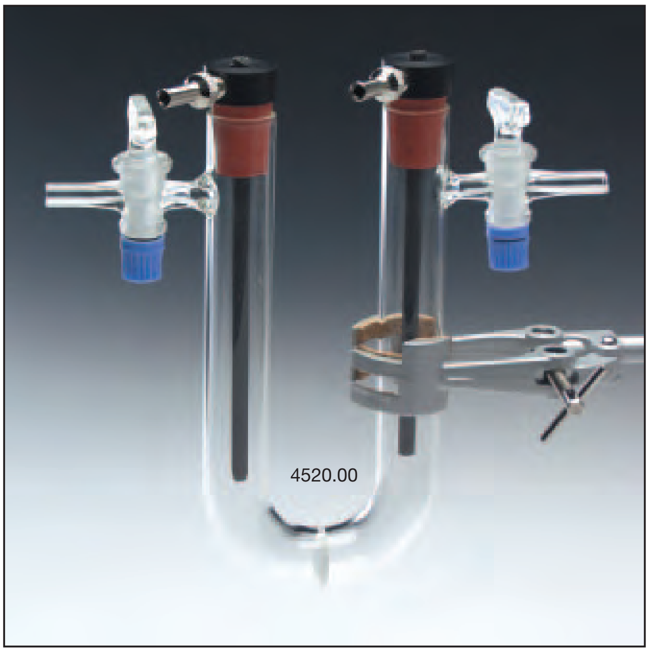
Square, massive copper nails with points.
Length: 70 mm. Cross section: 3 x 3 mm. Package of 10 ea.

4517.00 Copper electrode, copper nails

Steel plate for electro-galvanization

This is used for experiments with electro-galvanization.
Plate size: 20 x 40 x 1 mm.
Supplied with a 4 mm diameter hole for mounting.
Supplied in a package of 10 plates.

4518.00 Steel plates for electro-galvaization



U-tube with salt bridge

This is used in electrolysis where various electrolytes are used with the two electrodes. It can also be used for experiments with fuel cells.
It can be used with round electrodes mounted in rubber stoppers with a centerhole (0435.210) and electrode connectors (4513.00).
The U-tube is supplied with hose connectors and glass valves.
Size:
Internal diameter of the U-tube: 20 mm.
Center distance between branches: ca. 62 mm.
Overall height of U-tube: 170 mm.
External hose connector diameter: ca. 8 mm.
Supplied without electrodes.

4520.00 U-tube with salt bridge

4530.00

Student gas voltameter

For students' experiments. Embedded platinium electrodes with terminal bushes for 4 mm plugs. The gas is collected in the two miniature test tubes. (included) Made of acid-proof plastic.

4530.00 Student gas voltameter

4530.05

Electrolysis container lid

This item is used along with the electrolysis container item no. 4530.00 as a hydrogen supply for fuel cell no. 4528.50.

The lid is provided with two plastic tubes which are placed above the platinum electrodes of the electrolysis container so that hydrogen and oxygen can be supplied to the fuel cell.

The lid is provided with a silicone O-ring to ensure a stable and tight connection between the lid and the container.

Supplied with 60 cm long silicone tubing.

4530.05 Electrolysis container lid

Voltameter

For the demonstration of the gas quantity developed through electrolysis. The apparatus consists of a clear plastic jar with two platinium electrodes with 4 mm terminals. Supplied with 2 test tubes to collect the generated gas. Supplied with a movable mm scale to measure the height of the gas volume. Height 240 mm.

4530.10 Voltameter

4530.10
0
10
20
30
40
50
60
70
80
90
100
110
120
130

Electrostatics

Rods for electrostatics

For producing an electrostatic charge by rubbing with fur etc.

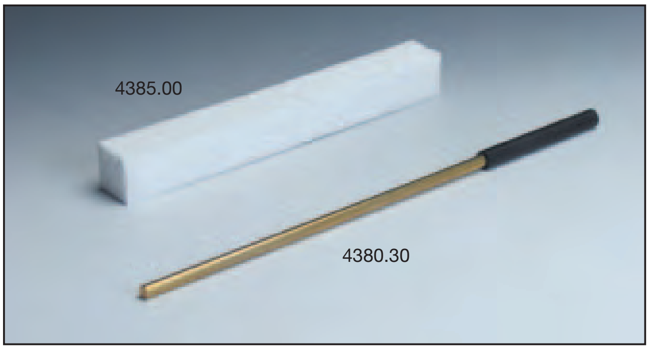
4380.00	**Perspex rod**	**250 x 12 mm diameter**
4380.10	**Glass rod**	**225 x 10 mm diameter**
4380.20	**PVC tube**	**300 x 16 mm diameter**
4385.00	**Polystyrol**	**30 x 30 x 250 mm**
4390.00	**Wollen cloth**	**20 x 20 cm**
4390.10	**Silk cloth**	**20 x 20 cm**
4390.21	**Rabbit fur**	**20 x 10 cm app.**

4380.10
4390.20
4395.00
4380.20
4380.00
4390.10
4390.00

Rotation stand

This holder with a rotating cradle for charged rods makes it possible to check the polarity of static electricity. Base diameter: 42 mm. Height: 95 mm. Mass: 45 g.

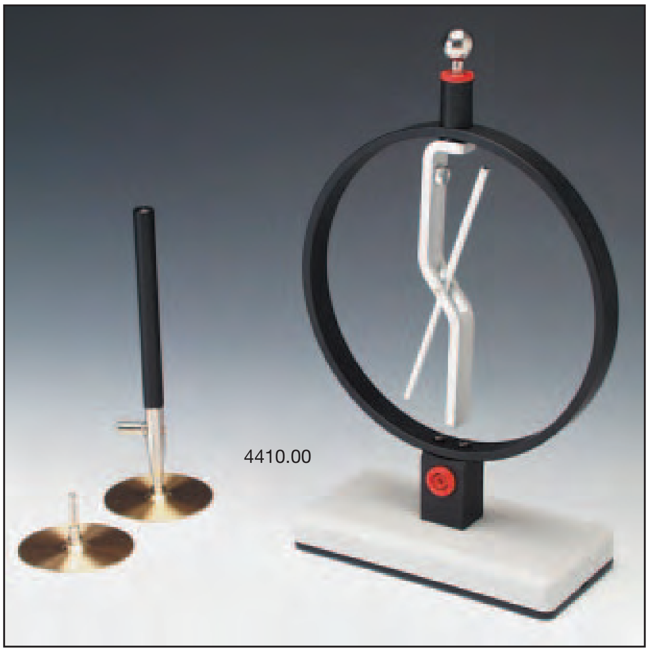
4395.00 Rotating stand with base



Brass rod with insulated handle

For showing that metals can acquire a static charge an insulated handle is a must to avoid unintentional discharge. Size: 250 mm x 8 mm diameter.
Shaft: 100 x 12 mm diameter insulated shaft.

4380.30 Brass rod with insulated handle



Electroscope

For the demonstration of static potentials. Available with charging ball plus a set of condenser plates with insulated rod. Ring diameter 150 mm.
Diameter of condenser plates 56 mm.

4410.00 Electroscope

4405.00
4415.00

Metal plated ping pong ball

The ball can be used to transfer and to study electrical charge. It is supplied with a thin nylon thread for hanging. Diameter: 38 mm. Mass: 2 grams.

4405.00 Metal plated ping pong ball

Metal plated ball on rod

The ball on a rod is used to transfer electrical charge. The ball diameter is 38 mm. Rod: 10 mm diameter x 130 mm long. Mass: 14 grams.

4415.00 Metal plated ball on rod

Pith balls

These 12 mm diameter balls of expanded polystyrene is used for demonstration experiments with electrical charge. Supplied in a plastic box with 10 ea.

4400.00 Pith balls

Insulated rod with hook

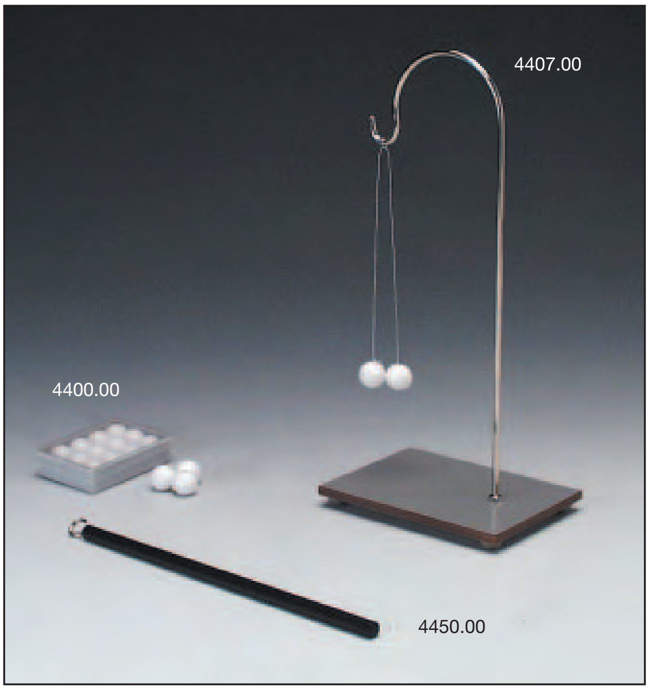
This rod is used for supporting the pith balls at some distance away from the hand when doing demonstration experiments with electrical charges and fields.

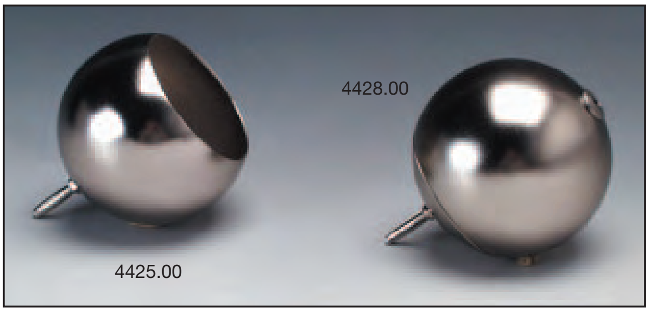
4450.00 Insulated rod with hook

Pith ball support

This support is supplied with a hook for conveniently holding a pair of pith balls connected by a string. Manufactured of nickel-plated brass with a plastic support base. Height: 220 mm. Support base: 100 x 70 mm.

4407.00 Pith ball support





Faraday ice pail

Used in conjunction with e.g. electroscope no. 4410.00, for the demonstration of load distribution on hollow metal bodies. Dimensions: Diameter 50 mm, length 97 mm. Provided with 4 mm plug pins.

4425.00 Faraday ice pail

Conducting sphere

For experiments in electrostatics e.g. examining the capacitance of a body, this item is useful. Sphere diameter: 68 mm. Provided with a 4 mm diameter jack for mounting on the insulated rod no. 4410.02.

4428.00 Conducting sphere, 68 mm diameter

Insulated rod

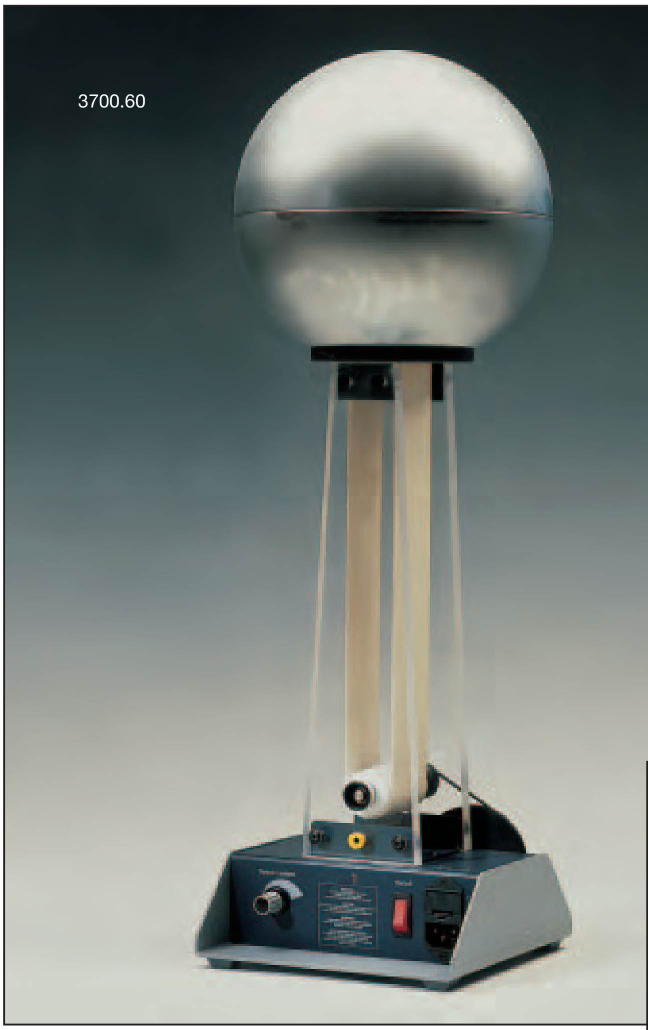
This item is good for insulated mounting of capacitor plates and conducting spheres when doing electrostatics experiments. The rod is providede with a 4 mm diameter hole to receive 4 mm jacks and connection bushings for laboratory safety leads.
Size: 145 mm x 10 mm diameter.

4410.02 Insulated rod

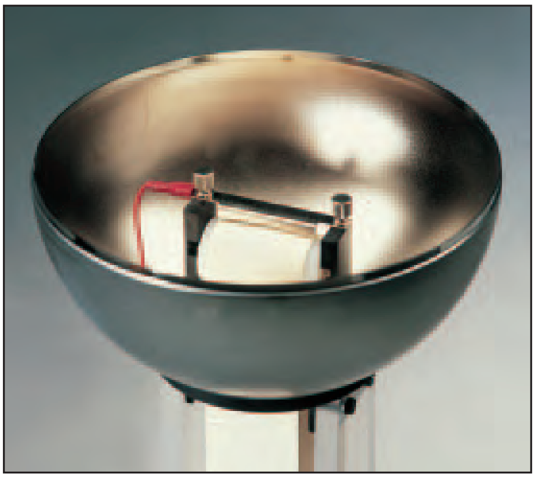
Zinc plate

This is used along with the electroscope no. 4410.00 for demonstrating the photoelectric effect. If the zinc plate is negatively charged and then illuminated by a UV light source e.g. UV mercury lamp no. 2865.00, then the electrometer will show how the plate discharges as electrons are removed by incident photons. (For best results lightly polish the zinc plate surface using fine steel wool.)

4410.03 Zinc plate



3700.60



When the conductor sphere is removed, the students can see the construction.

Van de graaff generator

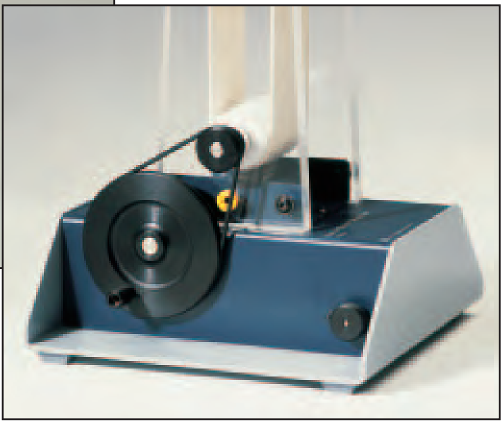
For the production of extremely high voltages with low currents. Spark length: Approx. 100 mm. Conductor sphere of 220 mm diameter, provided with 4 mm. diameter bush for plug. The sphere can be dismantled. The generator is operated by a 220 V AC motor with a motor speed control unit.
Dimensions: Height 560 mm, width 220 mm, depth 220 mm. Mass: 7.2 kg.
The Capacitance of the sphere is approx. 15 pF, and the sphere can easy be disassembled by lifting it upwards, so the princip of operation can be illustrated. The static electricity is generated from the rubberband, and the two plasticrollers.
The lower roller is turned by means of a rubberbelt connected to a variable engine, which means that the current from the sphere (approx. 6 µA), can be adjusted.

Technical Specifications:

Conducting sphere diameter:	220 mm.
Spark gap length:	80 – 100 mm.
Power Supply voltage:	230 V AC.
Total height:	560 mm.
Bottom plate size:	195 x 195 mm.
Mass:	4 kg.

Supplied with a protective plastic cover and manual.

3700.60 Van de graaff generator

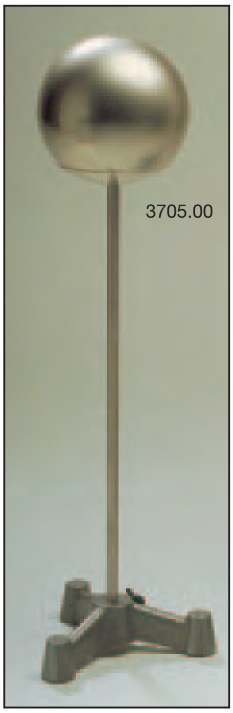


If desired the band generator can be driven by hand by moving the drive belt from the motor drive wheel to the handle drive wheel.

Conductor sphere on rod

Sphere for Van de Graaff Generator no. 3700.00. Diameter 100 mm. Mounted on a 410 mm long, Ø10 mm rod with 4 mm safety terminal. Mounted on an insulated base e.g. no. 0006.00 - not included.

3705.00 Conductor sphere on rod

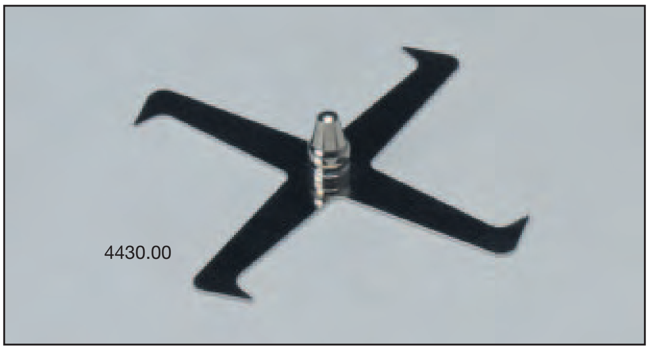


3705.00

Insulated stool

For use in experiments with static electricity. The base is covered with laminate and mounted on PVC legs. Legs: Diameter 30 x 35 mm. Plate: 305 x 305 x 20 mm. Mass: 1.5 kg.

4435.00 Insulated stool



Electric whirl for van de graaf

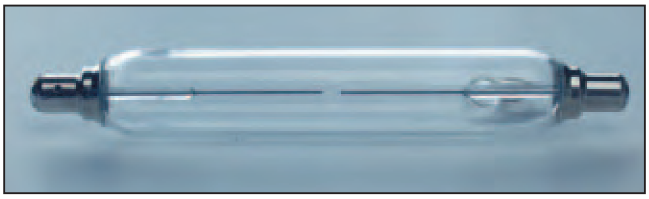
This unit has been redesigned. Comes with needle on dia. 4 mm plug, that fits the van de graaf.

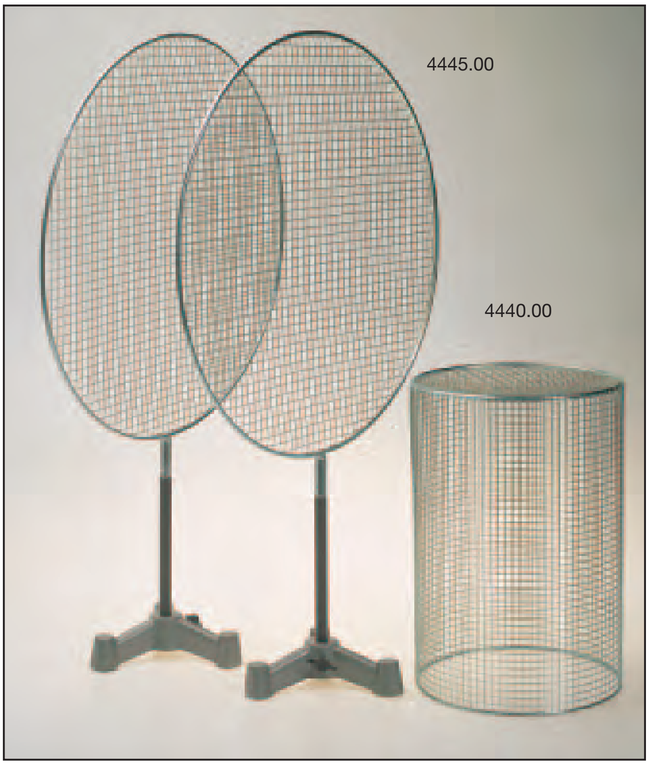
4430.00 Electric whirl for van de graaf

Discharge tube

Neon filled, for demonstrating electric charge and polarity.

4285.20 Discharge tube





Faraday's net

To show that an electrical charge resides on the external surface of a conductor and that the net acts as electric shield. Dimension: 320 x 210 mm diameter.

4440.00 Faraday's net

Metal net sheet

Used in pairs for the construction of plate condensers for large, uniform fields.
With insulated handle and 4 mm jack connection hole. Diameter 400 mm. Supplied in pairs.

4445.00 Metal net sheet

Magnetic field pattern

Conductor - single, working surface of 120 x 120 mm. Made in acrylic plastic with 4 mm sockets. Can be used on an overhead projektor.

4550.00 Magnetic field pattern

Magnetic field pattern

Single turn for use on an overhead projector to demonstrate magnetic field patterns with iron filings and plotting magnets.
Made in acrylic plastic with 4 mm sockets.
Working surface of 155 x 155 mm.

4550.10 Magnetic field pattern

Magnetic field pattern

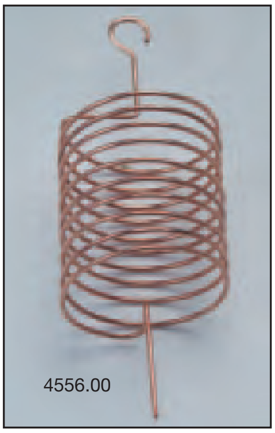
As no. 4550.10 but ten turns.

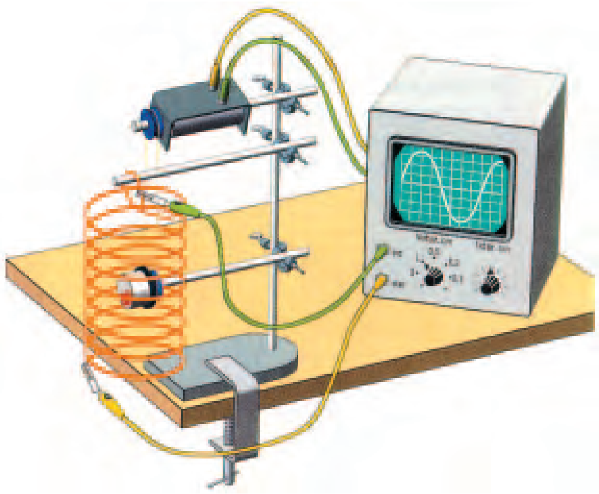
4550.20 Magnetic field pattern

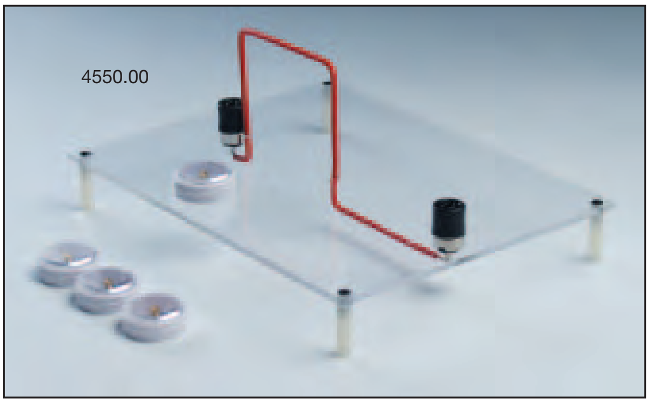
Induction coil, hanging

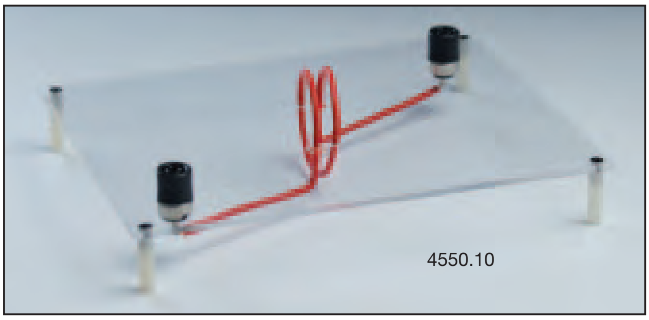
This is used along with a round magnet on the rotating bearing no. 3320.10 for demonstrating inducted voltages. Because the coil windings can be pulled apart the rotatable magnet can be mounted within the coil and caused to rotate using a small motor (no. 2025.00). The diameter of the copper coil wire is 2 mm. The length of the unstretched coil is 200 mm.

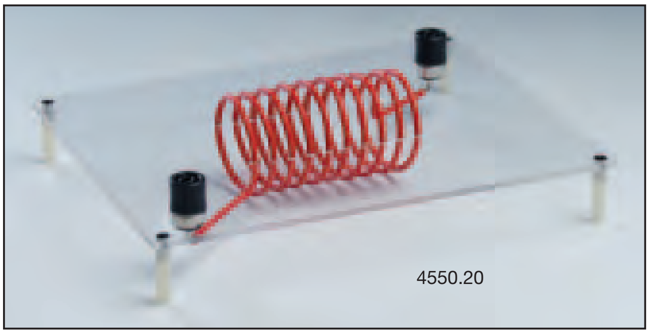
4556.00 Induction coil, hanging


4556.00




4550.00

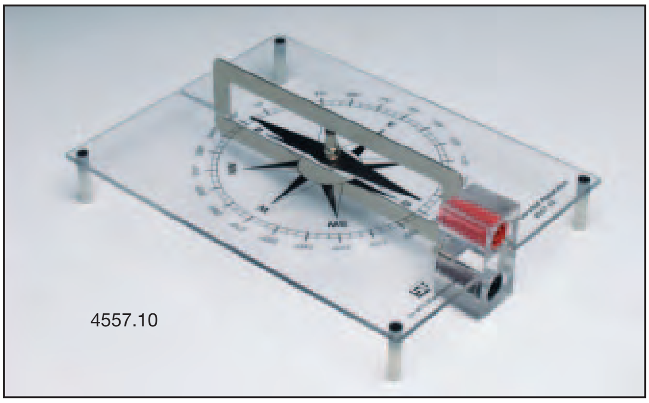

4550.10


4550.20

Hans Christian Ørsted's apparatus

This apparatus is used to demonstrate the action of a current bearing conductor on a compass needle. The compass needle and the current bearing conductor are mounted on a transparent acrylic plastic plate with a compass dial. A DC current of up to ca. 3 A is connected to the apparatus via 4 mm safety jacks to the conductor. This device is suitable for demonstration experiments performed on an overhead projector. Length of the compass needle: 105 mm.

4557.10 H.C. Ørsted's apparatus


4557.10

Pohl swing

For demonstration of the influence of a live wire in a magnetic field.
Dimensions:
Height 270, width 100, depth 160 mm.

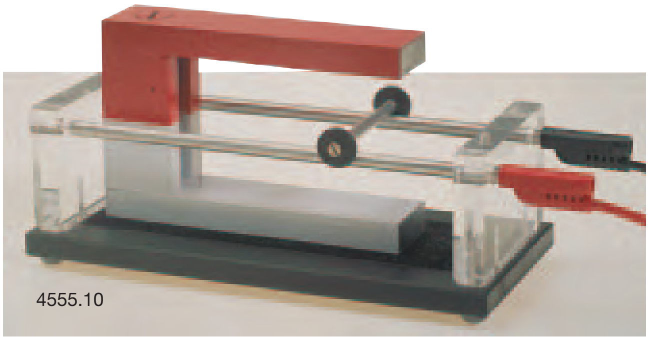
4555.00 Pohl swing

4555.00

Apparatus for Laplace's law

This apparatus is the force on a conductor in a magnetic field. It consists of a pair of aluminium rails with 4 mm terminals. An aluminium axle with plastic discs can roll freely along the rails and thus completes the electrical contact between them. A strong U-shaped magnet is required to complete the app., use e.g. our no. 3315.00 (not included). When the axle is placed on the rails between the poles of the magnet and power is applied via the rails terminals, the axle is strongly repelled. I.e. it rolls along the rails away from the centre of the magnetic field.
Dimensions: 190 x 85 x 65 mm. Net weight: 445 g.

4555.10 Apparatus for Laplace's law

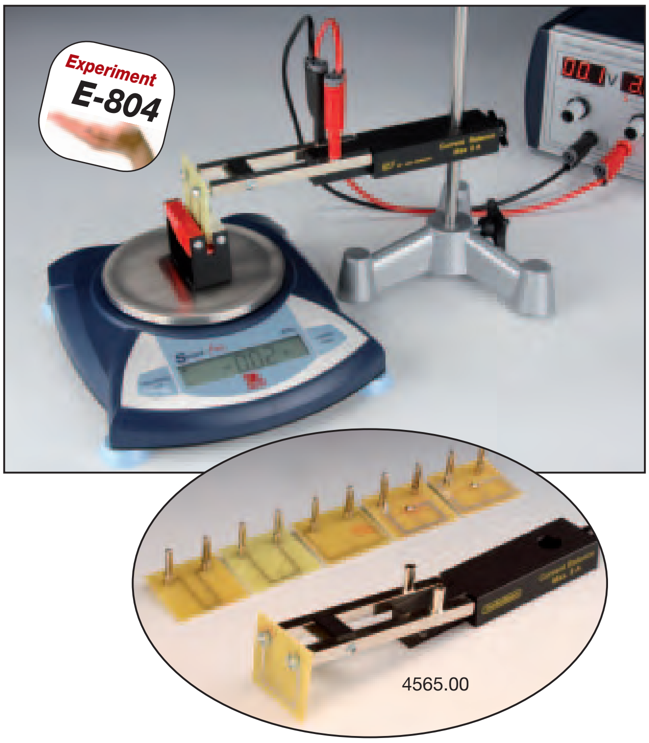


4555.10

Current balance II

For demonstrating and measuring an electric conductor's influence on a magnetic field in relation to the angle between the conductor and the magnetic field. The equipment consists of a homogenous, permanent magnetic field built up by four magnets in a holder.

4565.10 Current balance II

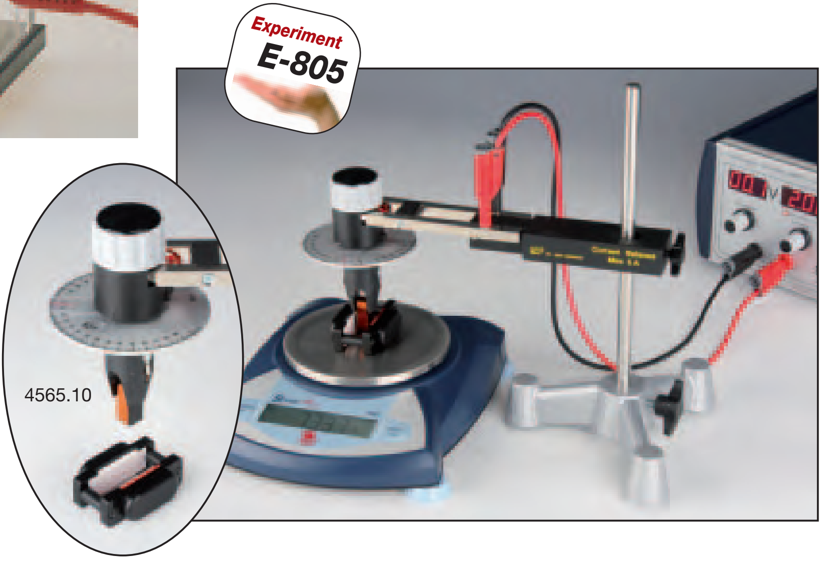


4565.00

Current balance I

For demonstration and measuring of an electric conductor's influence on a magnetic field.
The equipment consists of a magnet holder with interchangeable permanent magnets and a holder for wire frames which are mounted by means of 4 mm plugs.
For the experiment a top loading balance with 0.01 g accuracy and an 0-5 A, low voltage DC variable power supply are required.
The set consists of:
1 magnet holder with six permanent magnets.
1 holders for wire frames.
6 wire frames with wire lengths of 8 - 6 - 4 - 3 - 2 - 1 cm.

4565.00 Current balance I



4565.10

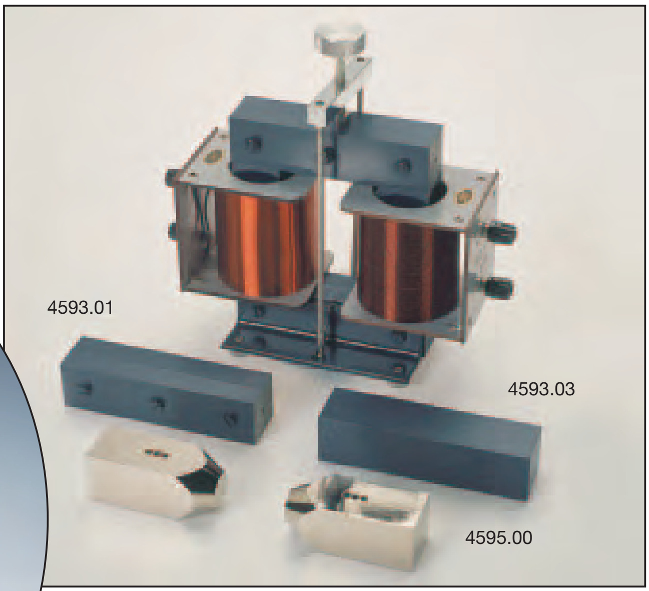
U-Core with armature

Laminated U-core and armature. Supplied with clamping stand. Used as transformer in conjunction with coils 4590.10 - .60. Cross-sectional area 32 x 32 mm.
Height incl. stand: 210 mm.

4593.00 U-Core with armature

4593.01 Armature, laminated

4593.03 Armature, solid



Pole shoe

To be mounted on U-core 4593.00. Cross-sectional area 32 x 32 mm.
Provided with pilot holes. Length 77 mm. NIckel-plated iron.

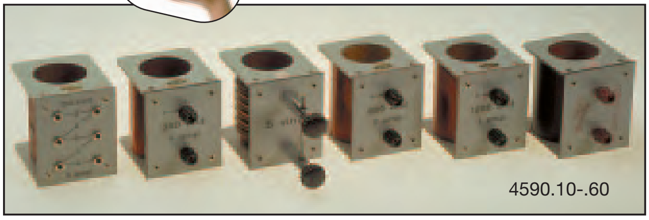
4595.00 Pole shoe

Coils

Suitable for U-core with armature and clamping stand. Provided with 45 mm dia. hole and insulated connector bushes. Height of coil 81.5 mm, width 70 mm.

No.	Number of windings	Inductivity	Max. Current
4590.10	6		
4590.20	120	0.4 mH	10A
4590.30	300	2.8 mH	4A
4590.40	600	10 mH	2A
4590.50	1200	42 mH	1A
4590.60	12000	5 mH	0.05A

Experiment
E-802



Melting trough

This copper melting trough is suitable for demonstrating induction heating. It is provided with a wooden handle. The medium can be water which will boil or lead (or ordinary solder) which will melt.

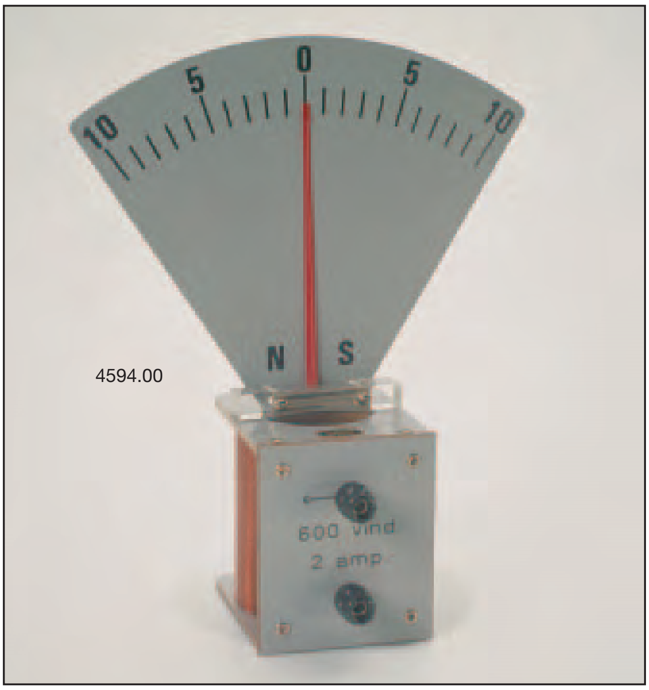
4596.60 Melting trough

Spot welding tongs

For demonstration of spot welding, with coil and copper electrodes.

4605.00 Spot welding tongs

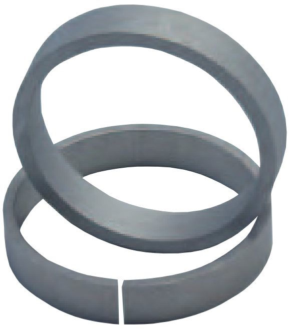
4605.00
4596.60



Galvanometer insert

Suitable for coils no. 4590.20-60.
With embossed graduation.

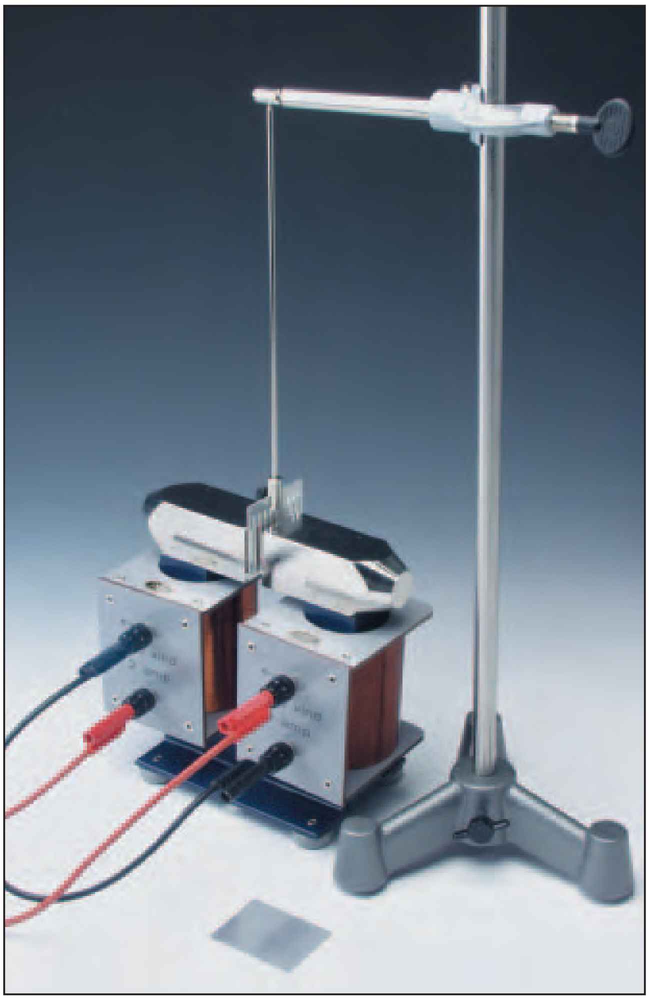
4594.00 Galvanometer insert

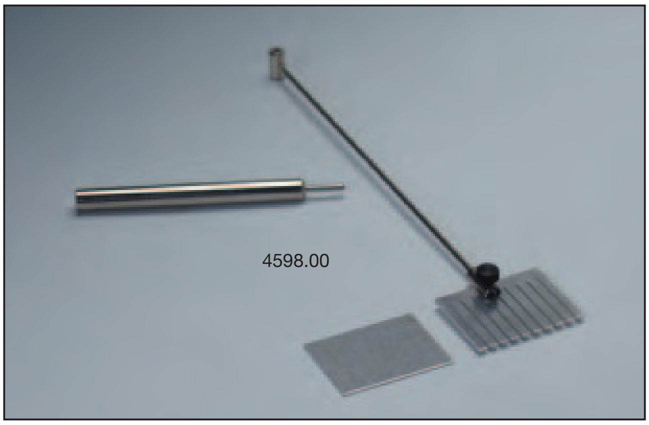


Thomson's rings

These are used to demonstrate the action of the magnetic force caused by an induced current. It is placed as the secondary coil and the force is observed.
The set consists of a continuous and discontinuous aluminum ring.

4600.00 Thomson's rings, set





Pendulum with plates

For demonstration of eddy-current braking capacity. Consists of plates with and without slots and pendulum with holder and bearing.

4598.00 Pendulum with plates

Carbon rod holders with 2 carbon electrodes

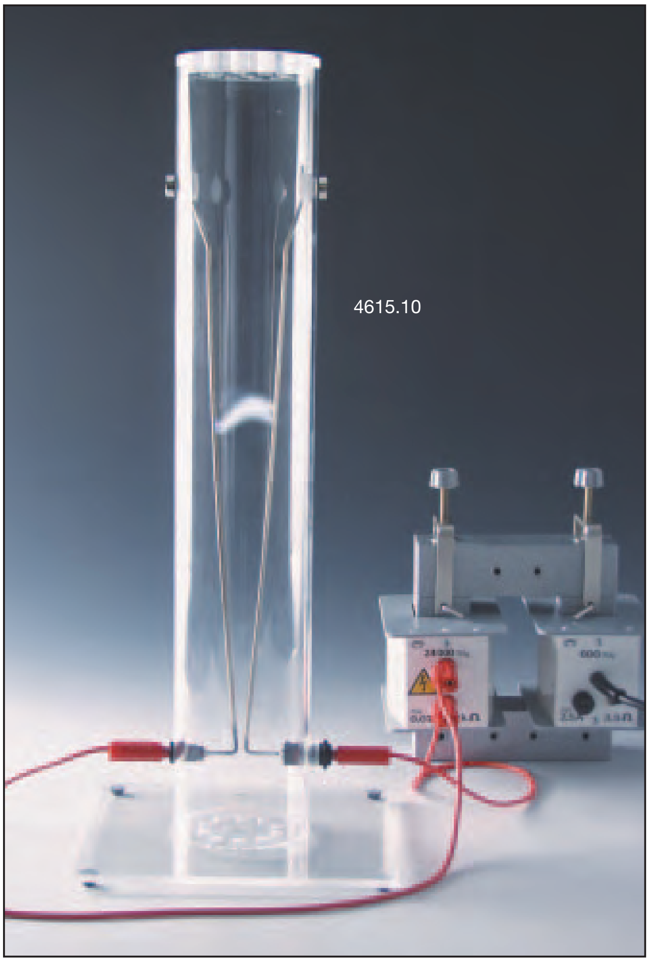
Cylindrical arc lamp graphite electrodes. These are used to produce electrical discharge arcs. The carbon rod holders fit the insulated supports no. 4350.10. Per set.

4610.00 Carbon rod holders with 2 carbon electrodes

Arc discharge rods

These are used for demonstrations of high voltage and the rising of high voltage arc discharges due to heating. For safety reasons the arc discharge rods are built into an insulated, protected acrylic plastic tube with safety jack connectors. One of the rods can be adjusted horizontally to bring the rods close enough together to start the electrical arc.
Height: 500 mm
Tube diameter: 90 mm
Bottom plate: 200 x 200 mm

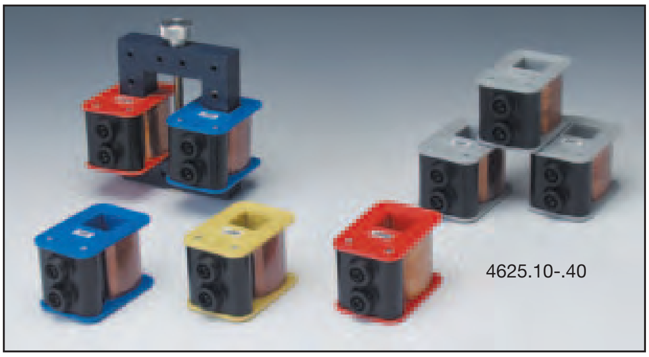
4615.10 Arc discharge rods

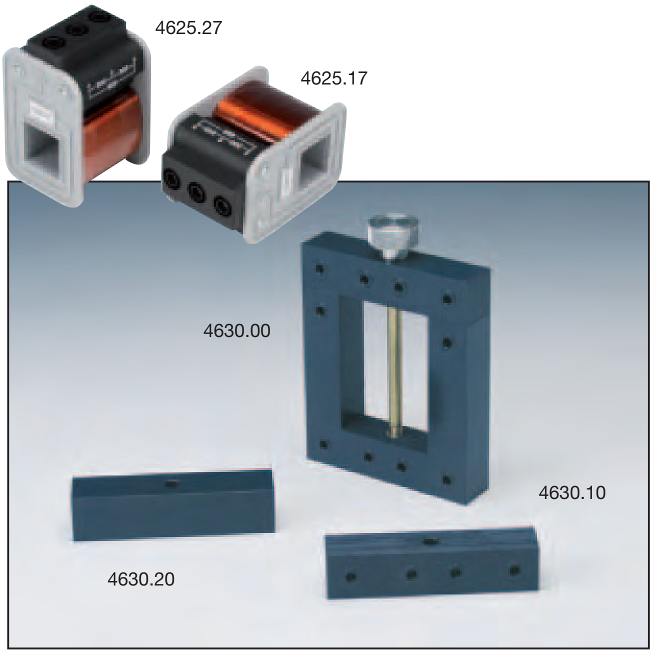


Transformer set, student

Coils for the student transformer. Made of colored plastic with 4 mm safety jack connectors.
The coil is provided with a transparent, adhesive polyester foil with an effective voltage insulation up to 4500 V to reduce the risk of electric shock. Hole size: 20.5 x 20.5 mm.

No.	Description	Number of Windings	Max. current	Resistance	Thread diameter
4625.10	Coil, blue	200	2 A	0.7 Ω	0.9 mm
4625.20	Coil, yellow	400	1 A	2.3 Ω	0.65 mm
4625.22	Coil, grey	600	0.75 A	4.3 Ω	0.56 mm
4625.25	Coil, grey	800	0.5 A	9.5 Ω	0.45 mm
4625.30	Coil, red	1600	0.25 A	33.3 Ω	0.34 mm
4625.40	Coil, grey	3200	0.125 A	146 Ω	0.22 mm
4625.17	Coil, grey	200/400	1 A	2,3 Ω	0,65 mm
4625.27	Coil, grey	300/600	0,75 A	4,3 Ω	0,56 mm





U-Core with armature

Laminated U-core with armature and clamp screw. Crosssectional area 20 x 20 mm.

4630.00 U-Core with armature

Armature, laminated

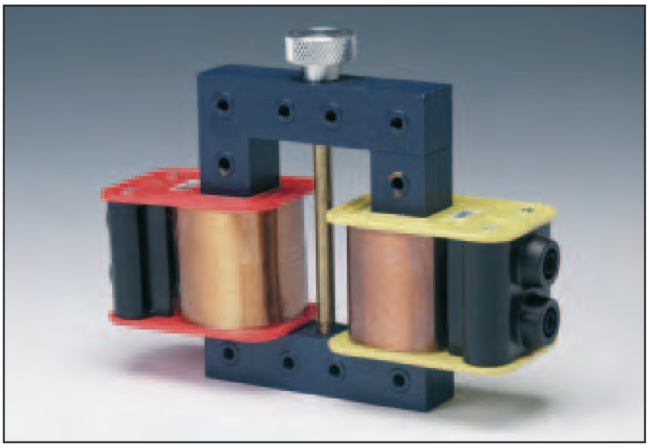
Laminated I-core. Size: 20 x 20 x 83 mm. Mass: 225 g.

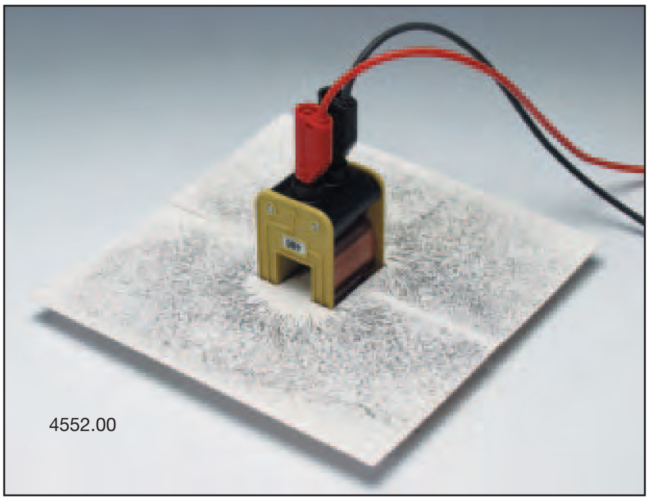
4630.10 Armature, laminated

Armature, massive

This massive I-core is for demonstrating the increase in power loss when using massive cores instead of laminated types. When the massive core is used it becomes warmer than the laminated. Size: 20 x 20 x 83 mm. Mass: 250 g.

4630.20 Armature, massive





Cardboard square for coil

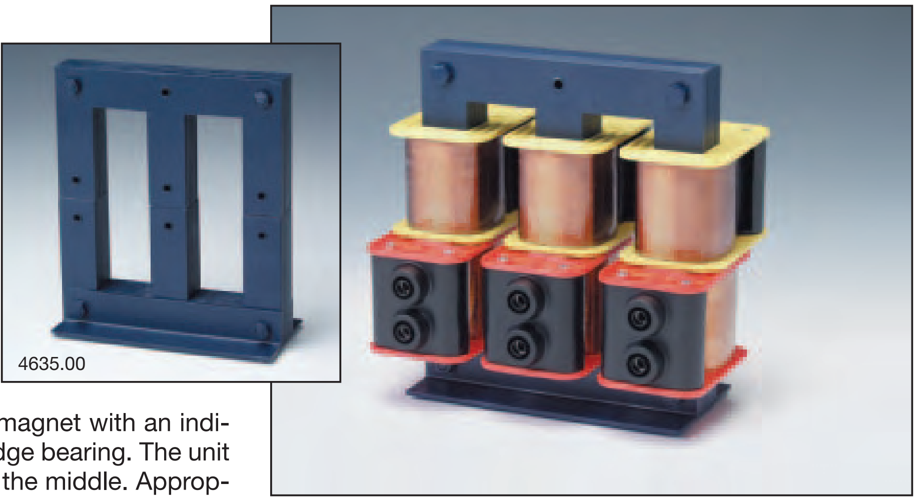
This cardboard square has cutouts for coil no. 4625.10. It is used for demonstrating the magnetic field around a coil using iron filings.

4552.00 Cardboard square for coil

E-Core with armature

Laminated E-core with armature. Crosssectional area 20 x 20 mm. Suitable for the construction of a three-phase transformer

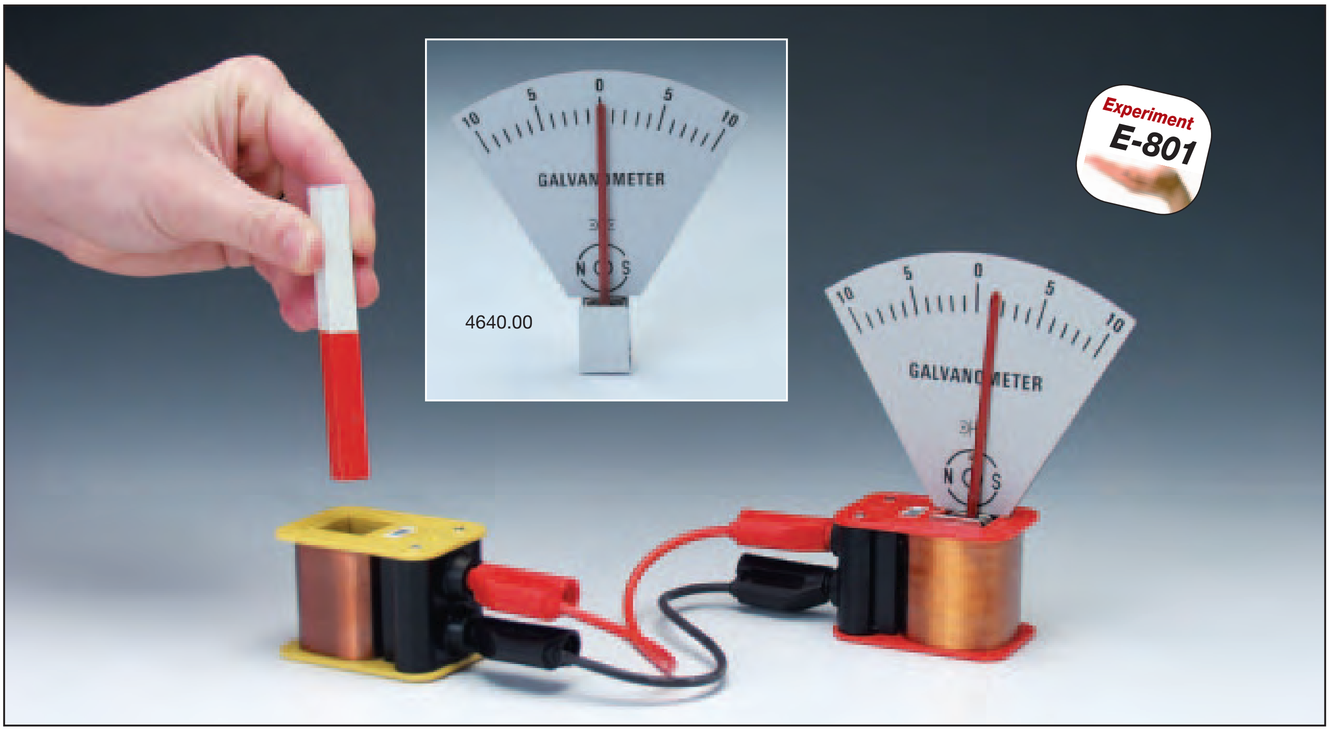
4635.00 E-Core with armature



Galvanometer insert

To build a simple galvanometer for showing induction of current. The insert consists of a permanent magnet with an indicator needle suspended in a knife edge bearing. The unit is provided with a scale with zero in the middle. Appropriate for use with coils no. 4625.10-.40.

4640.00 Galvanometer insert

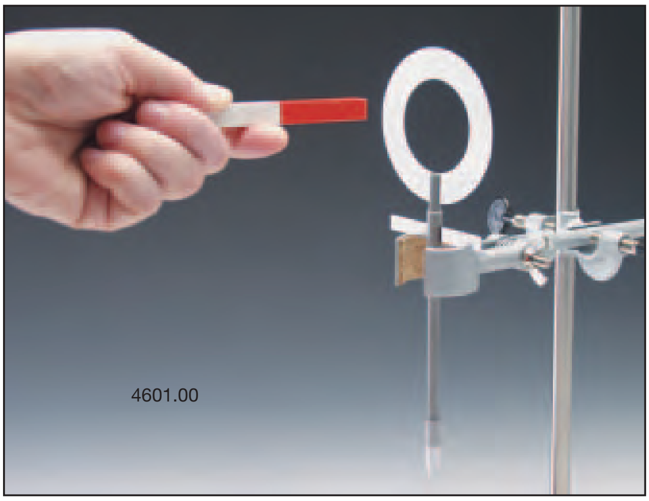


Induction

Eddy current ring

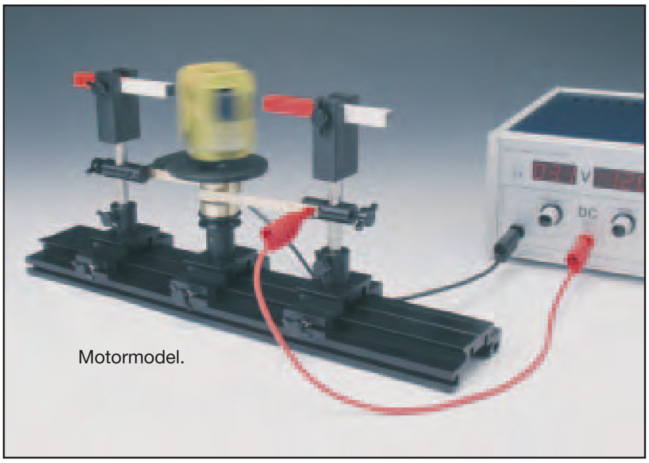
Used for demonstration of electromagnetic induction. When a magnet is pushed inwards towards the opening of the aluminum ring, an eddy current is generated, and a force will apparently be exerted on the eddy current ring.

4601.00 Eddy current ring



Motor/generator setup, single phase

This setup is for demonstration of one phase AC and DC generators and DC motors.
The setup used the profile track no. 2946.35 and three sliding holders no. 2946.10. This is a simple and easily understood setup where the operating principles of the AC/DC generator as well as the DC motor can be shown.


Motormodel.

Coil holder with commutator and collector

This item is used to build up the armature for the motor/generator using a 400 winding coil (no. 4625.20) and I-core (no. 4630.10). The coil with the I-core is mounted above on the four taps. Of these the smallest serves as the connection to the commutator below. It is designed so that it above and below can serve as a collector in constant contact with the coil. The middle section reverses the current for every half turn of rotation.
The coil holder is provided with a drive belt pulley below and a 10 mm diameter rotation axle rounded at the end so that it can serve as a pressure bearing against a surface.

Overall height:	142 mm
Overall diameter:	76 mm
Commutator/collector diameter:	30 mm
Drive belt pulley diameter:	28 mm
Length of drive shaft:	41 mm
Mass:	280 g

4708.00 Coil holder with commutator

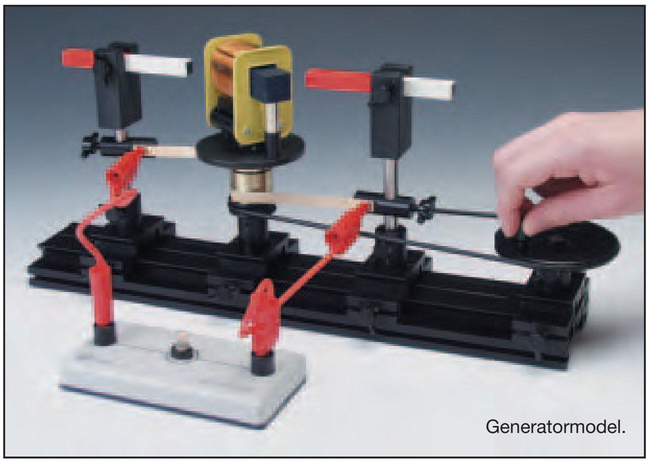
Commutator/collector contact springs

These contact springs are manufactured of phosphor bronze and mounted on plastic rods for the magnet holder no. 4708.10.
Each is provided with a 4 mm safety jack connector.

Overall length:	140 mm
Spring size:	8 x 0.5 x 100 mm

Plastic holder with 10 mm diameter hole and thumb screw

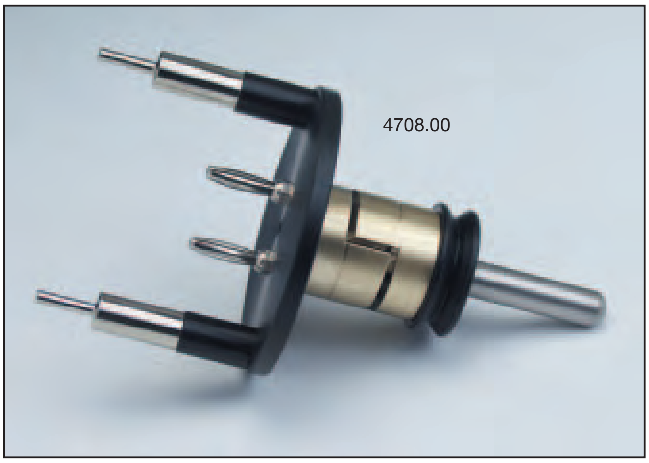
4708.20 Commutator contact springs

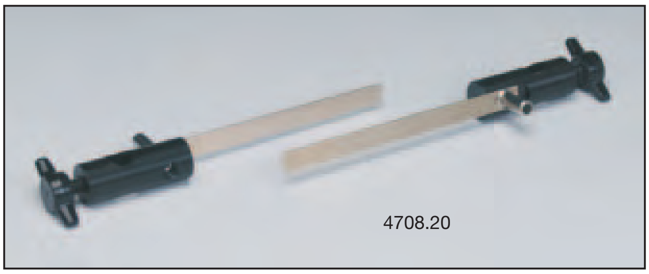

Generatormodel.

REQUIRED ACCESSORIES:

1 ea. coil, 400 windings, no. 4625.20
1 ea. laminated iron core, no. 4630.10
1 ea. coil support with commutator and collector, no. 4708.00
2 ea. contact springs for commutator/collector, no. 4708.20
2 ea. magnetic holders for motor/generator, no. 4708.10
1 ea. bar magnet, no. 3305.10

For support and mounting:
1 ea. profile track, no. 2946.35
3 ea. bench riders, 10 mm dia. mounting hole, no. 2946.10
1 ea. manual drive pulley, no. 4708.30
Power supply and drive belt


4708.00


4708.20

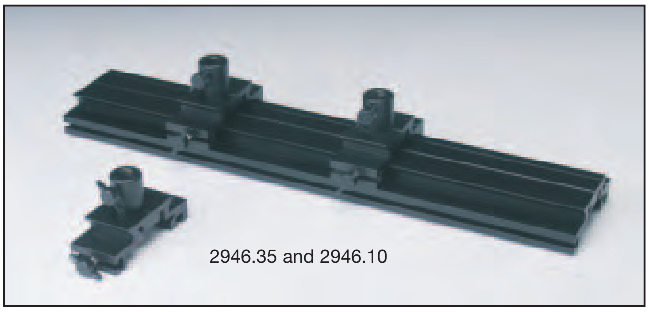
Manual drive pulley

This is used with the profile track no. 2946.35 and a bench rider with a 10 mm dia. hole, no. 2946.10, for providing rotation of a setup.
The drive pulley and the handle are manufactured of black plastic.
The handle is provided with a 10 mm diameter stainless steel axle which fits the hole in the bench rider.

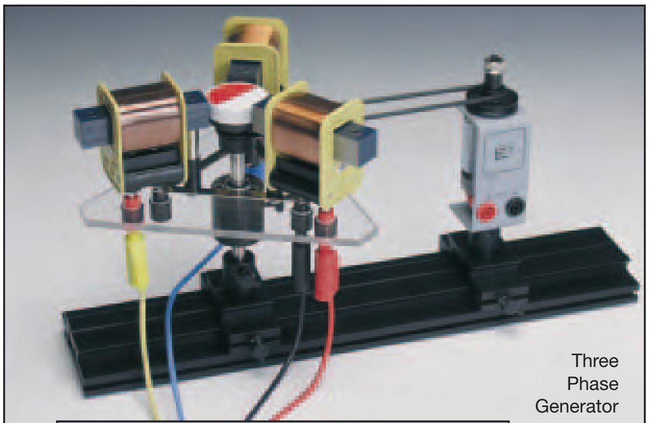
Pulley diameter:	77 mm.
Axle size:	10 mm diameter x 25 mm.

4708.30 Manual drive pulley

4708.30



2946.35 and 2946.10



Three Phase Generator

4735.00

Magnet support for motor/generator

This is used for mounting the stator magnets in the motor/generator construction. It is provided with a 10 mm diameter x 95 mm stainless steel tap. The holder is made of plastic with a cutout for 10 x 10 mm bar magnets no. 3305.10 (or 10 mm diameter magnets).

4708.10 Magnet support for motor/generator

4708.10

Profile track

The profile track is will suited for supporting items of experimental equipment which is to be mounted in fixed positions in relation to one another. The profile track is used with one or more track riders no. 2946.10. These are provided with a 10 mm diameter hole and wing nuts.

Track length:	370 mm.
Track width:	82 mm.
Track height:	26 mm.

2946.35 Profile track, without riders

Track riders with 10 mm diameter hole

These are designed for convenient mounting of equipment with a maximum 10 mm diameter mounting rod. They are finished with black lacquer and are provided with a measuring reference line and a wing nut.

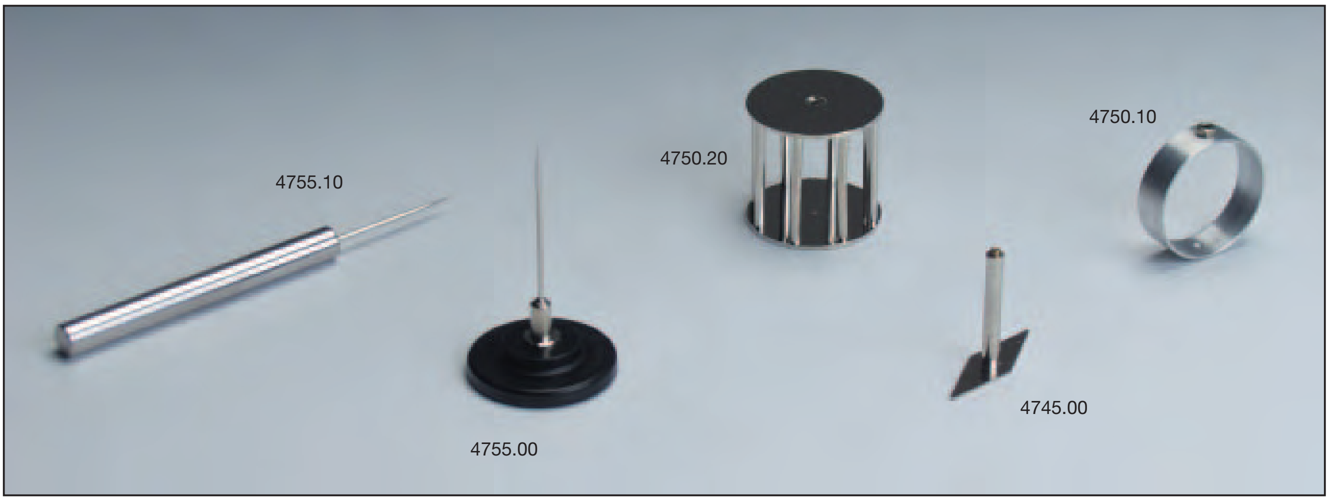
Size:	35 x 50 x 84 mm
Mass:	150 g

2946.10 Track riders with 10 mm diameter hole

Coil support, three phase

When demonstrating the principles of the three phase AC generator, the rotating field and the asynchronous motor, this item is useful.
A magnet with a rotation bearing no. 3320.10 (see page 70) can be used as the rotating permanent magnet armature. The coil holder for armature no. 4630.10 and the coils 4625.10-.40 may also be used. The coil support consists of a triangular acrylic plate with support arms for the armature with coils and bearings. There is a wing nut for securing to a 10 mm diameter rod. The product is supplied with 4 mm safety jack connectors. The edge length of the acrylic plate is 200 mm, the height is 80 mm and the mass is 270 g.

4735.00 Coil support, three phase



Magnetic needle with deep bearing

This is used as the rotor in the construction of a synchronous motor. The length of the needle is 60 mm. Mass: 5 g.

4745.00 Magnetic needle with deep bearing

Aluminum ring with bearing

This item is used in the construction of synchronous motors. The diameter of the ring is 35 mm. Mass: 10 g.

4750.10 Aluminum ring with bearing

Cage with bearing

This is used as the rotor in the construction of a synchronous motor.

4750.20 Cage with bearing

Needle on stand

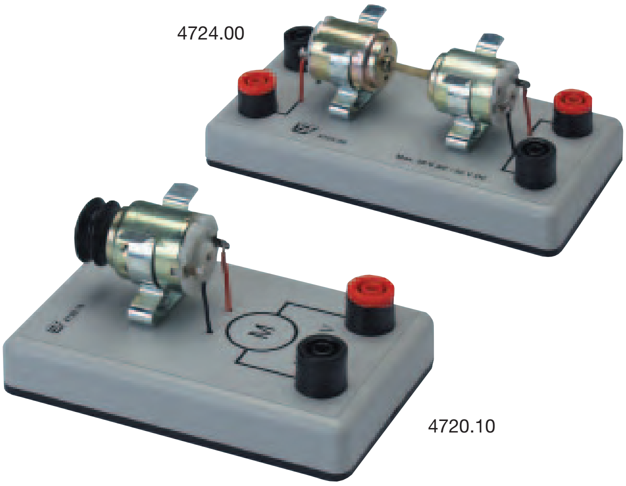
The needle is used to support items no. 4745.00, 4750.10 or 4750.20.

4755.00 Needle on stand

Needle on Rod

The rod and needle are used for experiments with rotating fields when using coil support no. 4735.00
4745.00 Magnetic Needle with Deep Bearing
4750.10 Aluminum Ring with Bearing
4750.20 Cage with Bearing
The rod is 10 mm in diameter x 90 mm. The overall length of the rod plus the needle is 135 mm.
Mass: 60 g.

4755.10 Needle on rod



Ganged motors

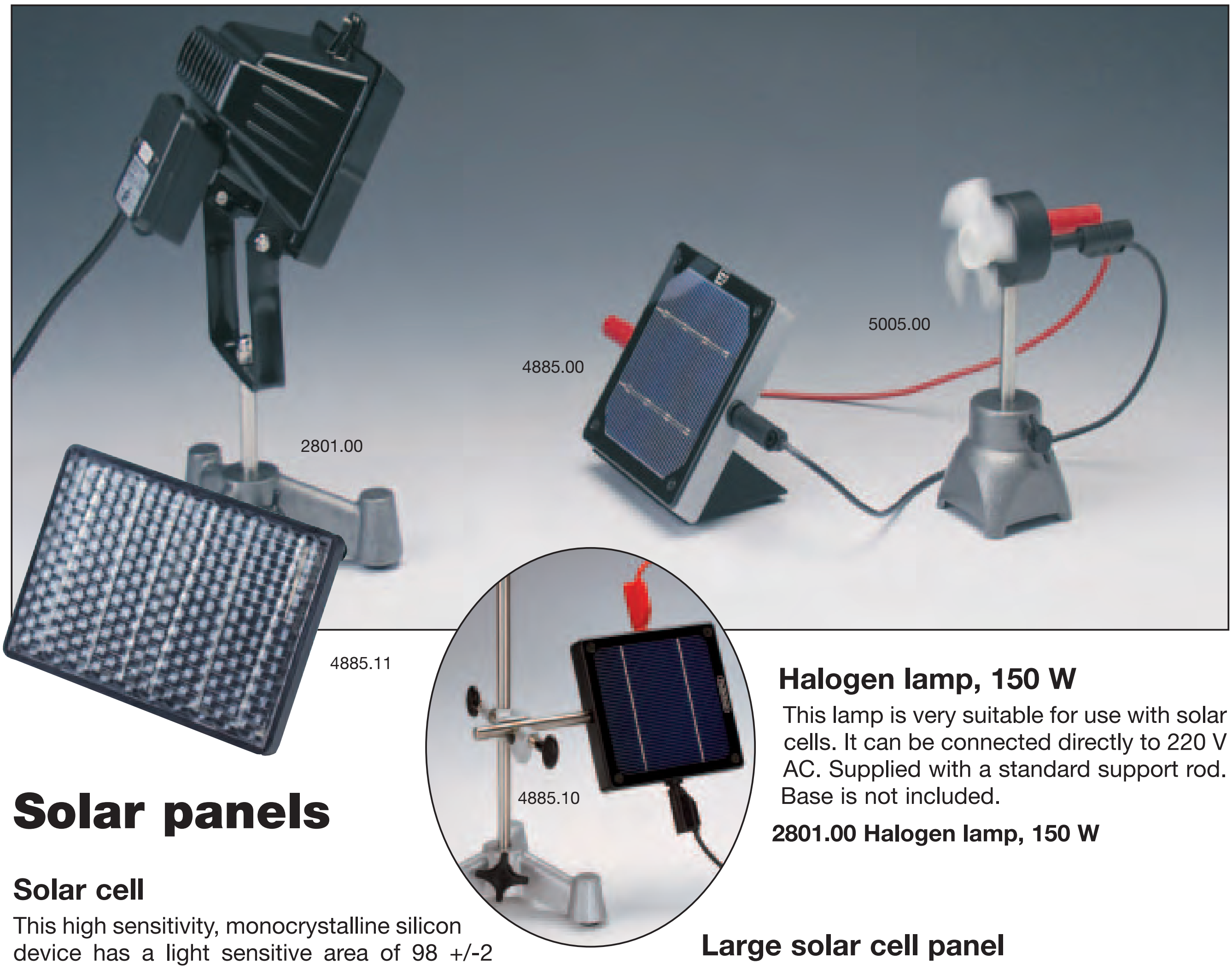
Two identical electrical motors are used for demonstrating the conversion of electrical energy. One of the motors can be used to turn the other so that it will operate as a generator. The two 6 V DC motors are conveniently mounted on a plate provided with 4 mm safety jack connectors.

4724.00 Ganged motors

Motor on support plate

The 2-6 V DC toy motor is mounted on a plate with two 4 mm safety jack connectors. A drive belt pulley is supplied.
Plate size: 70 x 100 mm.

4720.10 Motor on support plate



Solar panels

Solar cell

This high sensitivity, monocrystalline silicon device has a light sensitive area of 98 +/-2 cm^2. The output under “one sun” conditions is 0.48 V at 3.1 A. The Solar Cell can be connected to motor no. 5005.00 or no. 5015.00, motors with different electrical impedance. In high irradiance situations (e.g. direct sunlight) motor 5005.00 will barely rotate, while 5015.00 will. If a spotlight is used instead the propeller of motor no. 5005.00 will rotate.

4885.00 Solar cell

Solar cell, 3.1 A on rod

This solar cell is as 4885.00 but mounted on a 10 mm diameter x 95 mm supporting rod.

4885.10 Solar cell, 3.1 A on rod

Solar cell panel, 0.5 V/130 mA

This panel consists of two solar cells connected in series built into a shallow plastic casing with a clear acrylic cover. There are screws on the back of the unit for connecting leads to the panel. Size: 96 x 66 mm. U-max: 0.5 V. I-max: 130 mA.

4885.11 Solar cell panel

Halogen lamp, 150 W

This lamp is very suitable for use with solar cells. It can be connected directly to 220 V AC. Supplied with a standard support rod. Base is not included.

2801.00 Halogen lamp, 150 W

Large solar cell panel

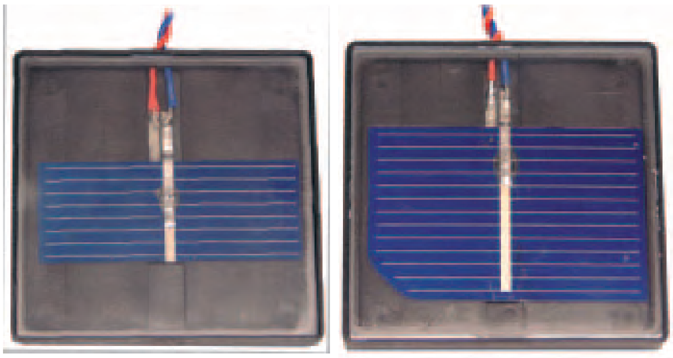
Large Solar Cell Panel, containing 10 minor Solar Cells, each 25 x 50 mm, mounted in series on an aluminium plate. Max voltage is 5V and max. Current is 300 mA at 1000 W/m2. Equipped with connecting cables.

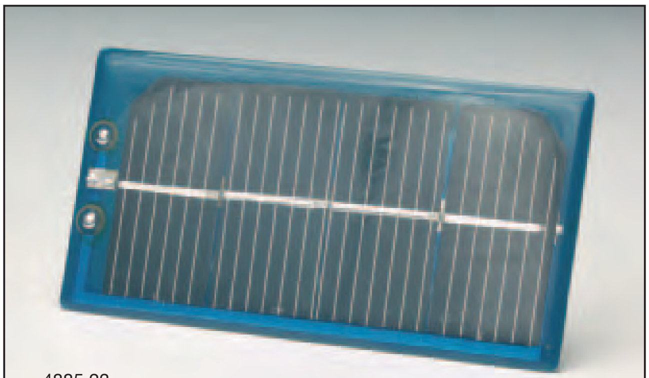
4885.35 Large solar cell panel

Solar cell panel 2 V

4 solar cells, 25 x 50 mm, in series on a pertiax plate.
2V, 300 mA.

4885.23 Solar cell panel 2 V





4885.23

Mono crystalline solar cell panels

Mounted in a cabinet of durable plastic, and equipped with connecting cables.

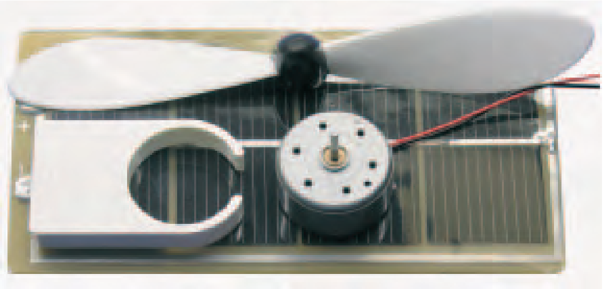
Part no.	No. of cells	Cell	Dimension	Housing dimension	Voltage Max current	Price each
4885.15	1	20x51 mm	60x60x7 mm	0,58 V	380 mA	39,00
4885.16	1	34x51 mm	60x60x7 mm	0,58 V	633 mA	71,00
4885.17	2	20x51 mm	60x60x7 mm	1,16 V	380 mA	59,00
4885.18	3	20x51 mm	90x60x7 mm	1,75 V	380 mA	108,50
4885.19	1	50x50 mm	90x60x7 mm	0,58 V	800 mA	52,00
4885.21	2	34x51 mm	90x60x7 mm	0,58 V	1,266 A	75,00
4885.22	2	34x51 mm	90x60x7 mm	1,16 V	633 mA	75,00

Solar cell panel, 50 W

Consists of 36 solar cells, 100 x 100 mm each, mounted on a large aluminium panel.
Max power: 19V & 3,5 A.

4885.20 Solar cell panel, 50 W

4885.20



4885.24

Solar cell w/ motor and propeller

Kit with solar cell module, low torque motor with holder and 2-blade propeller. Not assembled.

4885.24 Solar cell w/motor and propeller

Motor for solar cells

Electric motor

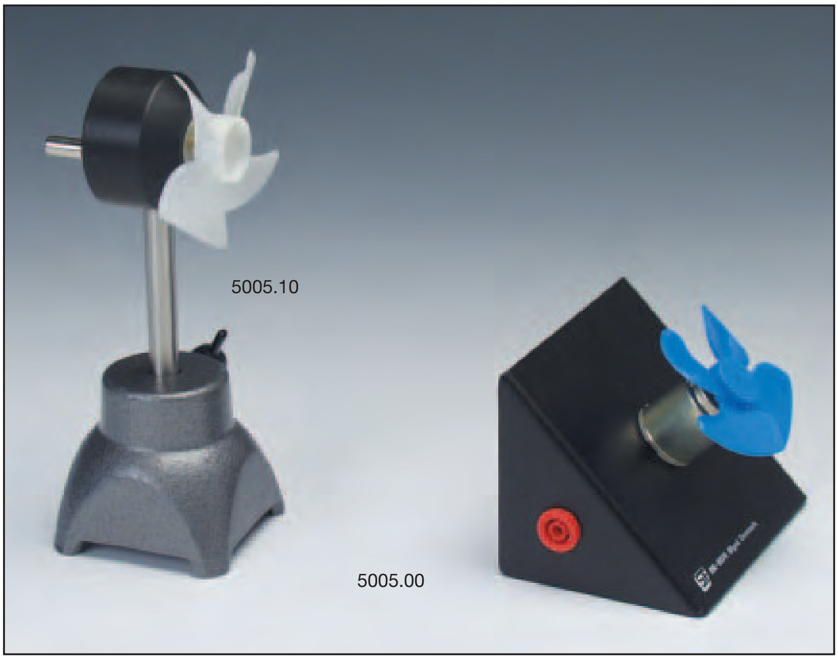
Can be used in conjunction with solar cell no. 4885.00-.10 for demonstration of the electrical current produced. Provided with propeller and 4 mm input sockets. Specifications: 0.2 - 3 V DC, 0-0.5 A.

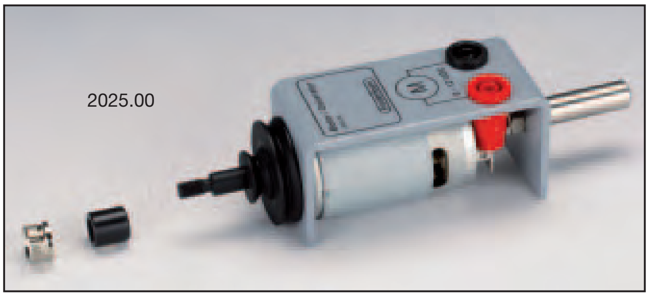
5005.00 Electric motor

Solar cell motor on rod

The motor is supplied with a small propeller and is suitable for use e.g. with the solar cell no. 4885.00. It is mounted in a housing on a standard 10 mm diameter x 105 mm support rod. Supplied with 4 mm safety jack connectors.

5005.10 Solar cell motor on rod





Universal motor/generator

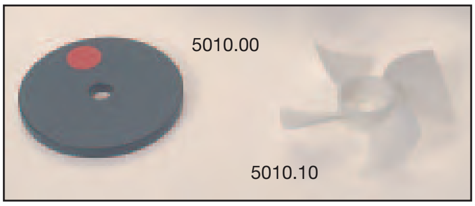
Operation voltage 0-12 v DC. Running speed 0 - 4800 rpm. Can be utilized either as a DC motor or as generator. Total length 220 mm.

2025.00 Universal motor/generator

Flywheel

To show conversion of kinetic energy to electrical energy and vice versa. Steel flywheel, 60 mm diameter, mass 105 g with hole 6 mm dia. For motor/generator 2025.00

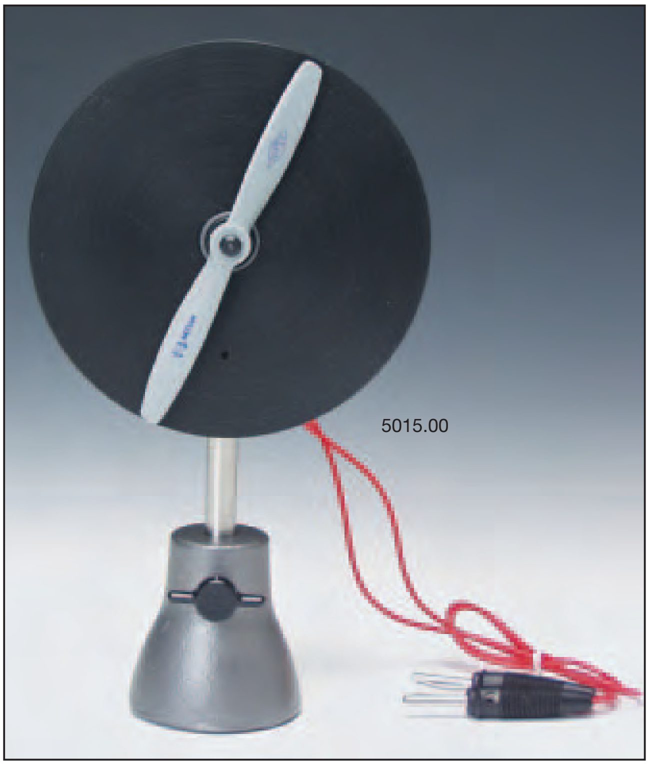
5010.00 Flywheel



Propeller

For demonstration of conversion of wind energy to electrical energy and vice versa. The propeller can be mounted on motor/generator 2025.00. Diameter 66 mm. Made of nylon.

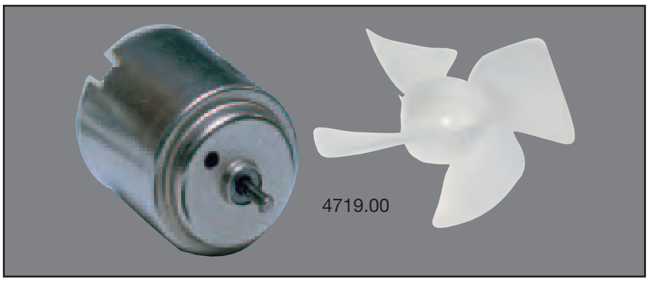
5010.10 Propeller



Low torque motor

This very low torque motor is mounted on a rod and supplied with a small propeller and protective rear panel to protect the blades against breakage.
The 1.5 V motor will start to turn at voltages as low as 35 mV. The nominal power dissipation is less than 0.3 W.

5015.00 Low torque motor



Motor and propeller for solar cell

Set of low-torque motor and 4-blade propeller

4719.00 Motor and propeller for solar cell

5046.00
5046.05

Propellers for wind mills

Sturdy plastic propellers originally designed for model aircrafts, but when mounted on 12V motor/generator, 2025.00, they will act as Wind Mills. They do not provide much power, but sufficient for student measurements.

Propeller, 30 cm

3-blade propeller, Ø 30 mm. with a Ø 8 mm bore, which fit the spindle on motor/generator, 2025.00.

5046.00 Propeller, 30 cm

Propeller, 40 cm

3-blade propeller, Ø 40 mm. with a Ø 10 mm bore, which fit the spindle on motor/generator, 2025.00.

5046.05 Propeller, 40 cm

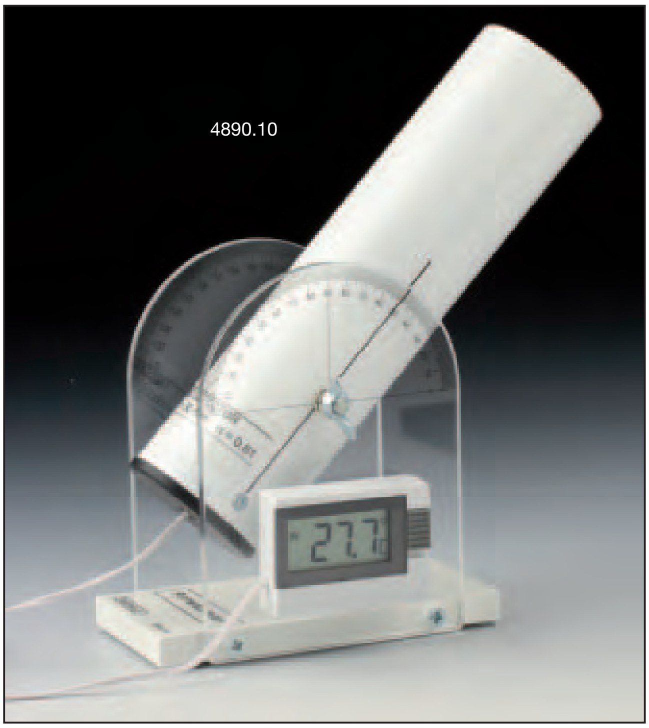
Solar measuring instruments

4890.00
CE 249SPC

Pyranometer

This instrument is intended for the measurement of the direct solar irradiance. The output signal is temperature compensated, and each instrument is individually calibrated. The output signal is directly proportional to the global solar irradiance in watt per square meter. An output signal of about 160 millivolts corresponds to an irradiance of 1000 W/m^2. All components are weather protected so that the instrument is suitable for mounting outdoors. Size: 10 x 10 x 2.5 cm.
Output signal: 0 - 200 mV

4890.10 Pyranometer



Pyrheliometer with digital thermometer

This instrument is designed to measure the direct solar irradiance. The detector at the bottom of the collimator tube is a black painted brass cylinder to which a digital thermometer probe has been mounted. Only the direct rays of the sun (and some circumsolar radiation) reaches the detector. The complete user's guide which is provided explains the pyrheliometer equation. This permits calculation of the solar irradiance from the heating of the brass cylinder. Measurements throughout the day permit the solar constant to be determined. The technique was first used by Pouillet in France in the 1830's and later by John Ericsson in the USA who was able to determine the solar constant with remarkable accuracy.

4890.00 Pyrheliometer with digital thermometer

Hand Pyranometer 4890.20
Frederiksen
543
W/m
4890.20

Hand pyranometer with display

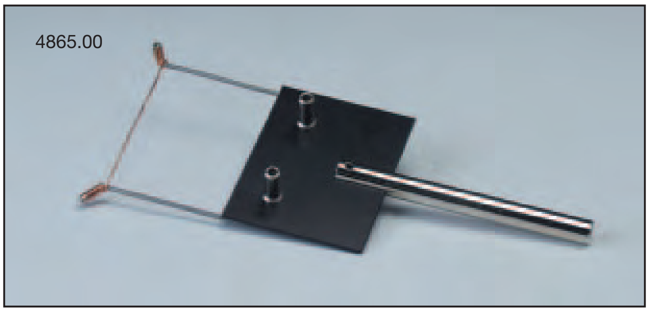
This instrument is designed for field measurements of global solar irradiance. It is supplied with a digital display for direct readout of the irradiance in watts per square meter. Two 4 mm safety jack terminals are provided so that the signal can, if required, be used by a remote unit like a datalogger. The device is powered by a 9 volt block battery (provided).

4890.20 Hand pyranometer with display

Heat energy

Thermocouple

This item can be used to illustrate the phenomenon of thermoelectricity. It consists of a piece of copper wire stretched between two pieces of constantan wire. The copper wire is wound and soldered securely to the constantan wire. If a temperature difference exists between the two junctions, an electrical potential (on the order of millivolts) can be measured between the two pieces of constantan wire. Supplied with 4 mm safety jack connectors and with a 10 mm diameter support rod.

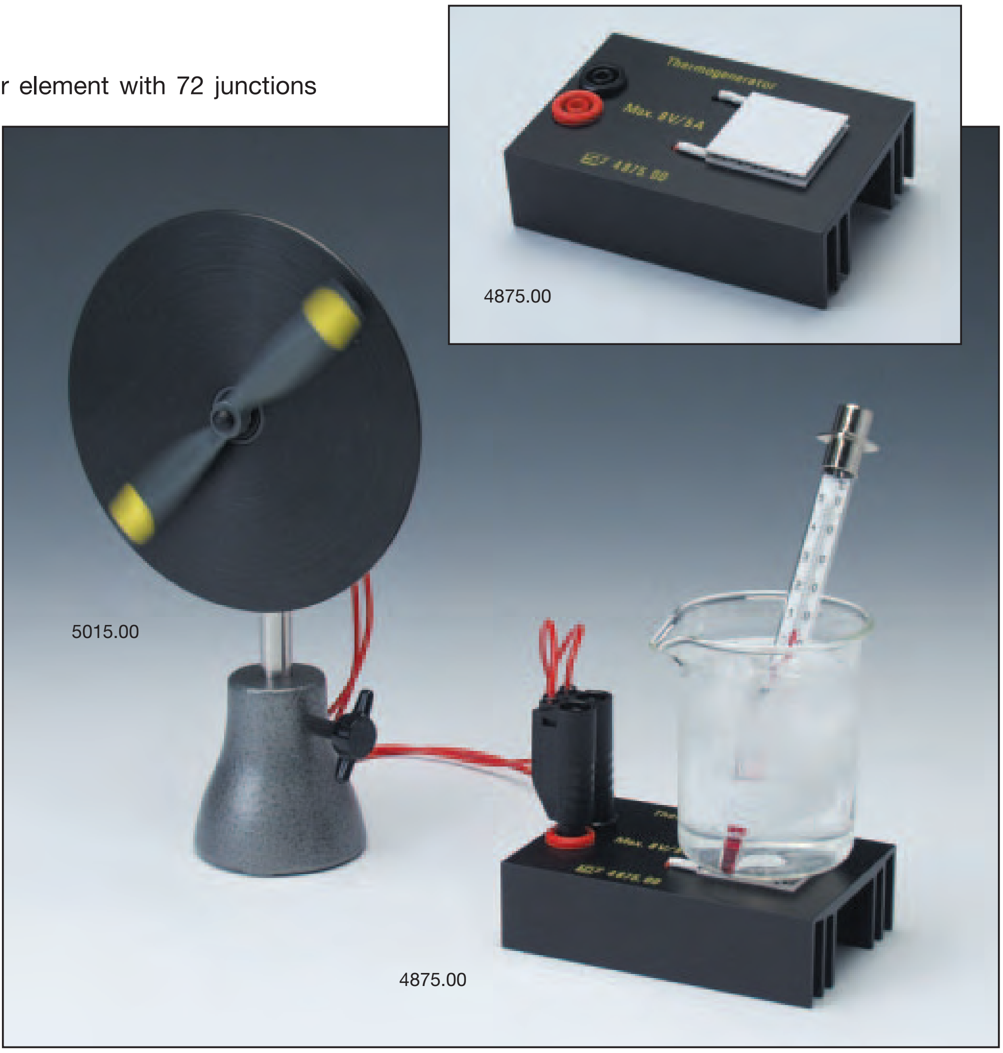


4865.00 Thermocouple

Thermal generator

The generator uses a Peltier element with 72 junctions connected in series and mounted on a cooling plates. If a temperature difference exists between the two sides of the element, then a potential difference will be generated (Seebeck effect). On the other hand, if a potential is supplied to the element, at temperature difference will appear between the two sides (Peltier effect).

The exposed side of the Peltier element can be readily heated or cooled e.g. using a metal container with hot or cold water. An electrical current can then be observed. The presence of this current is easy to show to a group using a small lamp (e.g. 1.5 V, 0.09 A - item no. 4250.05) or a low torque motor no. 5015.00. If a voltage is applied to the Peltier element to produce a temperature difference, then it must be no more than 8 V at 5 A.



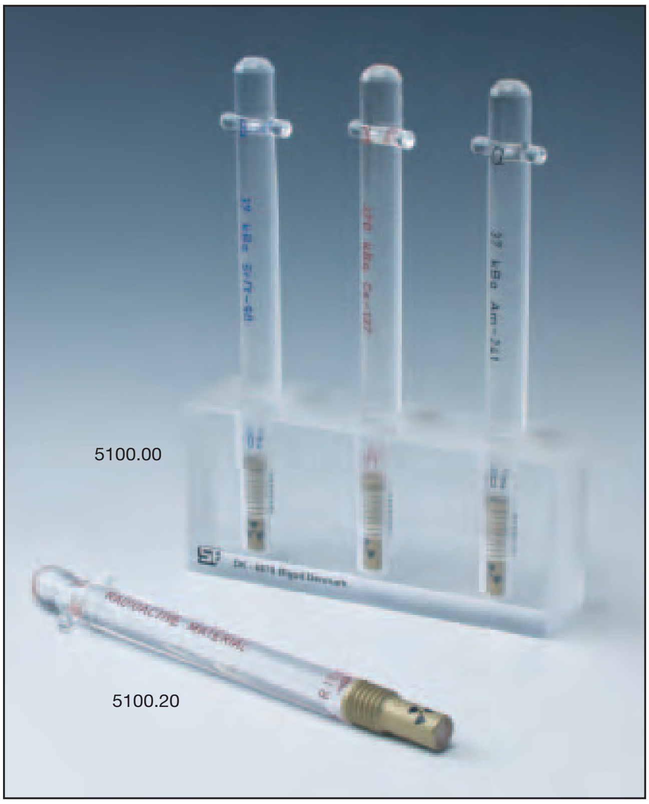
4875.00 Thermal generator

Radioactive sources

Radioactive sources

Sealed and protected. The active material is enclosed in metal foil sealed in a cylindrical mount provided with a handle of acrylic plastic. The sources threaded for mounting in a holder. The set consists of the following sources: Alpha-, Beta- and Gamma Source. Supplied in a storage holder.

5100.00 Radioactive sources, set with holder



Alpha source

The radioactive source is mounted in an approved holder with a plexiglass shaft threaded at one end for mounting in a support. The radioactive material is americium-241 (activity: 37 kBq, half life: 458 years).

5100.10 Alpha source

Beta source

The radioactive source is mounted in an approved holder with a plexiglass shaft threaded at one end for mounting in a support. The radioactive material is strontium-90 (activity: 37 kBq, half life: 28 years).

5100.20 Beta source

Gamma source

The radioactive source is mounted in an approved holder with a plexiglass shaft threaded at one end for mounting in a support. The radioactive material is cesium-137 (activity: 370 kBq, half life: 30 years).

5100.30 Gamma source

Storage holder

This plexiglass holder is convenient for storing all three sources.

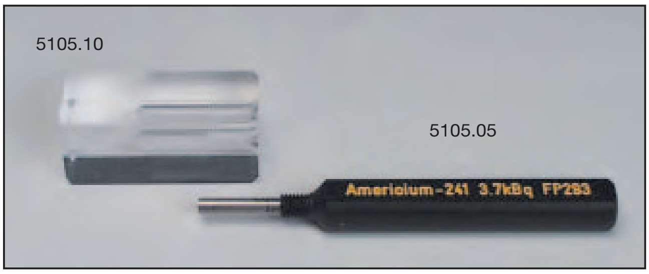
5100.40 Storage holder

Americium source for continuous cloud chamber (5120.00)

This radioactive alpha source is mounted in an approved holder with a black plastic handle threaded for convenient mounting in the cloud chamber.

Radioactive material:	americium-241
Activity:	37 kBq
Half life:	458 years

5105.05 Americium source for continuous cloud chamber (5120.00 page 152)



Plexiglass holder for americium source (5105.05)

This is a convenient protective storage option for the americium source.

5105.10 Plexiglass holder for americium source (5105.05)

5112.00

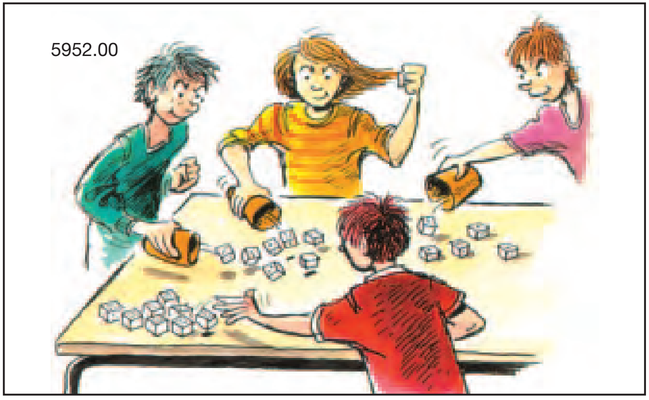
Isotope generator

The generator is designed to facilitate the leaching of a radioactive material for use in experiments measuring the radioactive half life. The leaching fluid provided permits a small amount of barium-137 to be drawn from the generator. This material decays by gamma emission with a half life of about 2.6 minutes. The isotope generator can be used up to 1000 times before replacement is required. By varying the amount of extraction liquid used the amount of Ba-137 can also be varied. After about 30 minutes the material has lost so much activity that it can safely be dispose of by simply pouring the liquid down the drain.

The isotope generator itself can also be used as a Cs-137 gamma source. The half life for cesium-137 is about 30 years, and the original activity of the isotope generator is 380 kBq.

NB: Use only the extraction liquid provided to leach out the barium-137. Use of other extraction liquids can destroy the isotope generator!

5112.00 Isotope generator



5952.00

Extraction liquid for isotope generator

This liquid is used to extract Ba-137 from the isotope generator item no. 5112.00. The bottle contains 250 ml.

5112.05 Extraction liquid for isotope generator

Potassium chloride in plastic container with secial lid

This item is designed for use with GM-tubes no. 5125.00 or 5125.05. (Please notice that 5113.00 is not compatible with our current range of GM tubes.) Natural potassium chloride contains a small amount (0.0117%) K-40 which is radioactive. This bottle is constructed so that the GM tube used to measure the activity will be completely surrounded by KCl without coming in direct contact with the material. This geometry ensures good counting statistics. A = 52 kBq. Contents: 325 g.

5113.00 Potassium chloride in plastic container with special lid

Potassium Chloride
Kaliumchlorid
KCl

5113.00

Dices

For simulation of radioactive decay. 100 pieces,

5952.00 Dices

Geiger-Müller tubes

5135.70

5125.15

5125.25

5135.65

GM Detector

This GM tube is mounted in a housing and supplied with a 6.3 mm male jack compatible with interface or counter type 2002.50. The GM detector unit has its own high voltage supply, so that only a standard 5 V DC external power source is required. The housing is provided with a protective cover. The unit can detect alpha, beta and gamma radiation.

5135.70 GM Detector

GM detector, BNC connector

The GM tube is mounted in a housing and suppled with a 10 mm diameter support rod. Supplied with a protective cover. This unit has a BNC connector, compatible with GM-counter 5135.30 or 5135.35 and it can detect alpha, beta and gamma radiation.

5125.15 GM detector, BNC connector

GM detector, extra sensitive with BNC connector

This extra sensitive GM Detector has an extra large window with an effective diameter of 27.8 mm. This makes the Detector well suited for measuring low activity sources. The large window provides more counts and thus improves counting statistics for more accurate determinations of half lives, etc. The GM Detector housing is supplied with a protective cover as well as a protective grid in front of the window. Alpha, beta and gamma radiation can be detected, but not alpha due to the window thickness. The unit has a BNC connector.

5125.25 GM detector, extra sensitive with BNC connector

GM detector, extra sensitive

This extra sensitive GM Detector connects directly to the digital input of a interface via a 6.3 mm jack. It can also be connected directly to counter type no. 2002.50. The GM Detector has a built in high voltage supply and requires only a 5 V DC supply. The tube has an extra large window with an effective diameter of 27.8 mm. This makes the tube particularly well suited for measurements of low activity sources. The large window provides more counts and thus improves counting statistics for more accurate determinations of half lives, etc. The GM Detector housing is supplied with a protective cover as well as a protective grid in front of the window. Alpha, beta and gamma radiation can be detected.

5135.65 GM detector, extra sensitive

Technical data for 5125.05 and 5135.70

Self-contained GM tube, halogen gas filled with mica window.
Recommended bias voltage: 500 V.

Window area:	78 mm^2
Window diameter:	10 mm
Window density:	15-20 mg/cm^2
Window material:	mica

Technical data for 5125.25 and 5125.65

Self-contained GM tube, halogen gas filled with mica window.
Recommended bias voltage: 575 V.

Window area:	607 mm^2
Window diameter:	27.8 mm
Window density:	20-30 mg/cm^2
Window material:	mica

Geiger-müller counters

5135.55

Ratemeter, analog

This ratemeter is a battery operated portable GM-counter ideal for field use and equipped with a built-in GM-tube. The built-in GM-tube is sensitive to Alpha-, Beta-, and Gamma-radiation.
Developed and designed especially for educational purposes:
With analog moving coil meter: No flashing digits but continuous and stable readings, so students always have a good idea about the level of radiation.
Output for TTL pulses. Analog output for external applications. Size: 205 x 109 x 53 mm. Mass: 720 g.

5135.55 Ratemeter, analog

5135.30-.35

Geiger-müller counter

Geiger-Müller counter for use with Geiger-Müller tube no. 5125.05 or 5125.25. Equipped with digital readout and gate time options of 1 sec., 10 sec., 100 sec. and infinitely. Adjustable G-M voltage 200 - 600 V with digital display of voltage by means of push-button. Output for digital scaler. Battery driven portable instrument to indicate beta, gamma and high-energy alpha radiation. Size: 220 x 108 x 52 mm.
Adaptor no. 3550.00 can be used if desired to connect to 220 V AC.

5135.30 Geiger-müller counter

Geiger-müller counter

Same as 5135.30 but supplied with a RS232 port.

5135.35 Geiger-müller counter

2002.50

Counter

This microprocessor controlled counter has a 25 mm high LED display and is well suited for demonstration experiments in the classroom.
The counter can be connected directly to GM Detectors via a 6.3 mm jack receptacle. The following GM Detectors are compatible: 5135.65 and 5135.70. TTL type signals from other GM detectors or GM amplifiers can also be used. The counter is provided with an RS232 serial interface for connection to a PC and is compatible with the DATALYSE data collection program.
Counting times: 1 s, 10 s, 60 s, 100 s and manual. All of the fixed counting times can be selected for continuous or non-continuous measurements. See page 17 for a more detailed description of the counter.

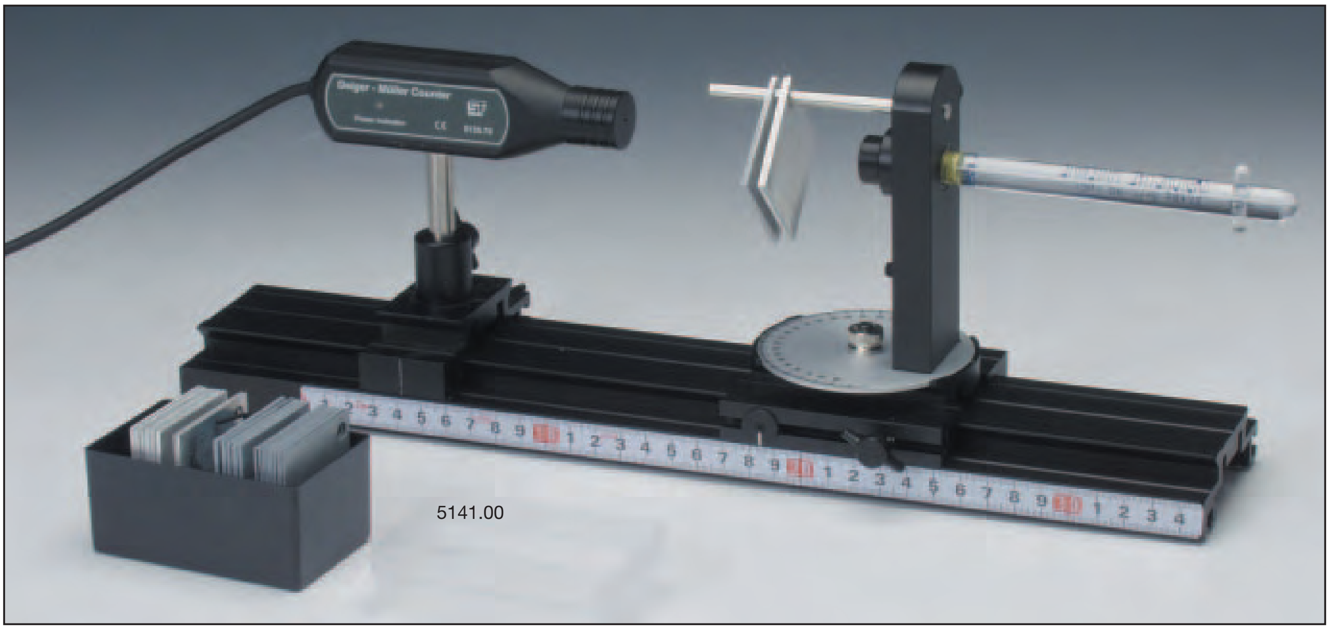
2002.50 Counter

Bench for experiments with radioactivity

Bench for Radioactive Sources and GM-tubes, providing a stable and convenient setup, allowing reproducible results when making experiments with radioactivity. Investigate how the radioactive radiation spreads from the source in both angle and distance or investigate how radiation is absorbed by lead and aluminium.

Comprises a 60 cm long bench, with a mm-scale, holder for GM-tubes and holder for radioactive Sources. The later can be fitted with a diameter 6 mm steel rod, for hanging absorber plates in front of the radioactive source. The included absorber plates are supplied in a convenient storage box, and includes: 5 ea. 2mm and 10 ea. 1 mm thick lead plates plus 2 ea. 3 mm; 6 ea. 2mm and 4 ea. 0,5 mm Aluminium plates. The lead-plates have been enamelled to protect fingers from lead contamination. The holder for the radioactive sources can be turned, and is fitted with a degree-scale, +/- 110 degree, 1 degree resolution.

5141.00 Bench for experiments with radioactivity



GM detector holder for support bench

This holder is designed for GM Detectors type 5135.65 and the extra sensitive GM Detector type 5125.25.

5141.01 GM detector holder for support bench

Holder for extra sensitive geiger-müller tubes

Fits GM-tube 5125.25 and GM-sensor 5135.65. Fitted with a Ø10 mm mounting rod, so the GM-tube may be held safe in a retort stand base (0004.10).

5125.32 Holder for extra sensitive geiger-müller tubes

Good News: A wider range of sources can now be used with our equipment

Although A/S Frederiksen only provides the radioactive sources shown in this catalogue, other popular types can now be used with our equipment.
The two new types are the 12 mm cylindrical sources (as provided by for instance Phywe and Leybold) - and the 25 mm disk sources (as provided by for instance Pasco and Spectrum Techniques).
Please refer to the table below for the relevant item numbers

Selection Guide	**Type 1** **(Frederiksen)** 	**Type 2** **(disk)** 	**Type 3** **(cylindrical)**
Source holder on rod including abs. plates	5140.05	5140.25	5140.35
Source holder on rod without abs. plates	5140.07	5140.27	5140.37
Bench for experiments with radioactivity	5141.00	5141.20	5141.10
Deflection of beta particles	5141.05	5141.25	5141.35
Beta spectrum apparatus	5165.00	5165.20	5165.30

Accessories for geiger-müller counters

Datalyse

Software for use with Geiger-Müller counters 5135.35 or 2002.50 (communicates with other Frederiksen instruments as well) when logging data on PC. Well suited for measurements of radioactive decay or absorption of radiation.

Freeware – See page 166.

1123.05 Serial cable

25 pin male/9 pin female. Connects Geiger-Müller counters 5135.35 or 2002.50 to PC's with 9-pin serial ports.

1123.20 Serial cable

25 pin male/25 pin female. Connects Geiger-Müller counters 5135.35 or 2002.50 to PC's with 25-pin serial ports.

3550.10 Power supply

9V power supply for Geiger-Müller counters 5135.30, 5135.35 and 5135.55. 230V European plugs only.

BNC to Jack Adapter

5125.75

Adapter

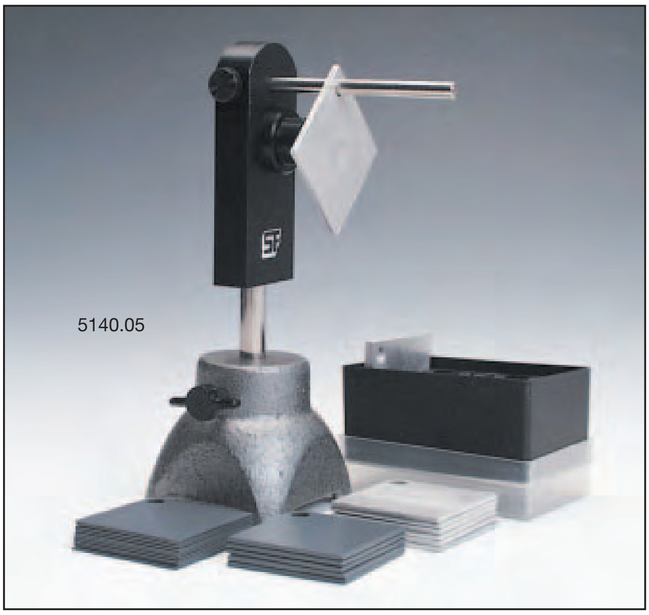
with build-in high tension supply for geiger tubes with BNC connector (for instance 5125.05, 5125.15).
The output lead of the adapter has a 6 mm jack connector for our digital counter 2002.50.
The adaptor is also compatible with Pasco's digital adapter PS-2159.

5125.75 Adapter

Source holder on rod incl. absorber plates

The holder is designed for radioactive sources and supplied with a set of absorber plates for experiments with radioactivity. The holder has a 10 mm diameter support rod and a 6 mm diameter rod for hanging absorber plates in front of the radioactive source. The absorber plates are supplied in a convenient storage box. The set includes: 5 ea. 2 mm thick lead plates and 10 ea. 1 mm thick lead plates. The plates have been enameled to protect fingers from lead contamination. Aluminum plates are also supplied: 2 ea. 3 mm, 6 ea. 2 mm and 4 ea. 0.5 mm.

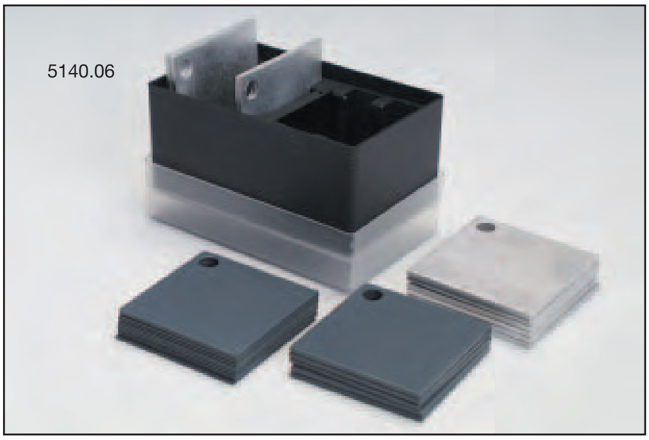
5140.05 Source holder on rod incl. absorber plates


5140.05

Absorber plate set

The set of absorber plates is supplied in a storage box. The set includes: 5 ea. 2 mm thick lead plates and 10 ea. 1 mm thick lead plates. The plates have been enameled to protect fingers from lead contamination.
Aluminum plates are also supplied: 2 ea. 3 mm, 6 ea. 2 mm and 4 ea. 0.5 mm.

5140.06 Absorber plate set


5140.06

Absorber plates; 45 x 45 mm

All plates have a 7 mm diameter hole in one corner for hanging them on a support.

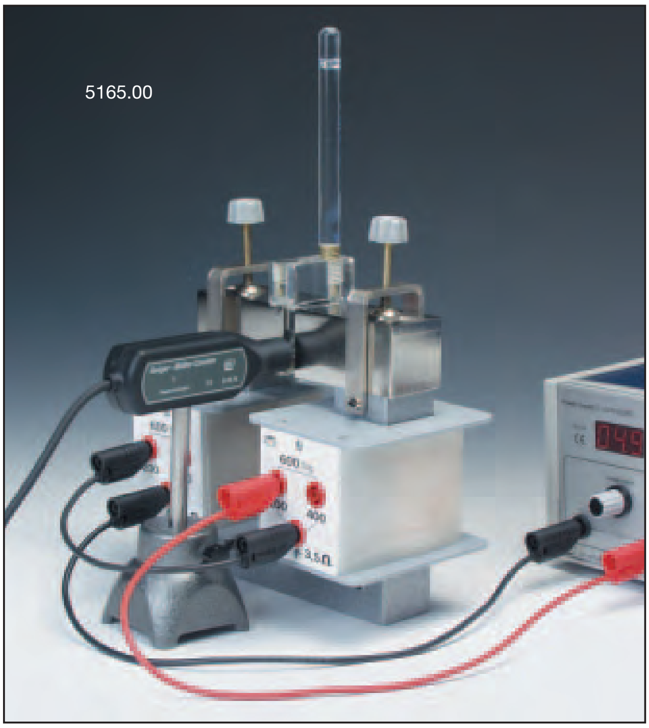
5140.10 Lead plate, enameled, thickness: 1 mm
5140.11 Lead plate, enameled, thickness: 2 mm
5140.12 Aluminum plate, thickness: 0.5 mm
5140.13 Aluminum plate, thickness: 2 mm
5140.14 Aluminum plate, thickness: 3 mm

Beta spectrometer apparatus

The apparatus is placed in a variable magnetic field. The deflection of beta particles emitted from a source depends upon the strength of the magnetic field. The radiation is detected at the end of a circular channel for a variety of field strengths. There is a support for the beta source with a circular cutout and a cutout for a Hall detector. An electromagnet pole assembly and coils are also needed for the experiment.

5165.00 Beta spectrometer apparatus

5165.00


5165.00

Teslameter

This instrument is ideal for determining the strength of the magnetic field when doing experiments with 5165.00 Beta spectrum apparatus or 5141.05 Deflection of beta particles.
For a detailed description, see page 98.

4060.50 Teslameter

4060.50
5141.05
Experiment
E-1003

Deflection of beta particles

The deflection of beta particles is easily demonstrated with this accessory for the bench for experiments with radioactivity (5141.00). The magnetic field is provided by a pair of strong permanent magnets. The direction of the field can be reversed and the magnets can be removed altogether.
A beta source is mounted in a collimator that can turn around the centre of the magnets, thereby changing the angle between the incoming particle beam and a Geiger-Müller detector.
To demonstrate the effect of the magnetic field on the beta radiation, you start with the magnets removed from the apparatus and align the beta source and the detector. When the magnets are re-introduced, the radiation "disappears". By changing the angle between source and deflector, the radiation can be found again – but only if the magnetic field is oriented correctly.
From the angle of deflection the kinetic energy of the particles can be deduced. This way the energy spectrum can be sketched to show its continuous nature.

5141.05 Deflection of beta particles

Diffusion cloud chamber

Continuously operating diffusion cloud chamber for the observation of a particle tracks. Diameter 120 mm, height 90 mm. With the aid of approx. 50 g dry ice and 1-2 ml alcohol, the traces of fog can be observed for about 30 min. The chamber requires no high-voltage sources; it is equipped with a 12 V lamp.
Without radioactive preparation.

5120.00 Diffusion cloud chamber

Irradiated seeds

Simple plant experiments for demonstration of the effect of radiation on plants

With this experiment the effects of increasing radiation doses on plants can be observed. It will also be found that radiation is more harmful to some plants than to others. Five different types of irradiated seeds can be supplied: barley, wheat, rapeseed, flax and yellow mustard. The seeds are supplied in sets with 6 different radiation dosages: 0 kilorad, 10 kilorad, 40 kilorad, 80 kilorad and 160 kilorad with about 40 seeds for each dosage. The gamma irradiated seeds are not radioactive, so the experiments with them are completely safe.
The seeds are sown in short rows in a planting box e.g. no. 0520.30. The material is placed in a bright window sill to germinate. The plants should begin to sprout within 7 to 12 days depending upon the seed type and the temperature. The height of the plant corresponding to each radiation dose can be measured and compared. The effect of different radiation doses on plant growth can also be studied. Supplied with instructions.

7791.10 6 x 40 Barley seeds
7791.11 6 x 40 Wheat seeds
7791.12 6 x 40 Rape seeds
7791.13 6 x 40 Flax seeds
7791.14 6 x 40 Yellow mustard seeds
7791.20 Set with all 5 seed types

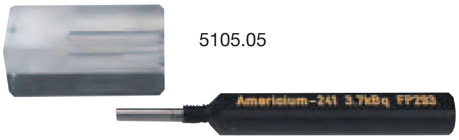
This experiment shows:

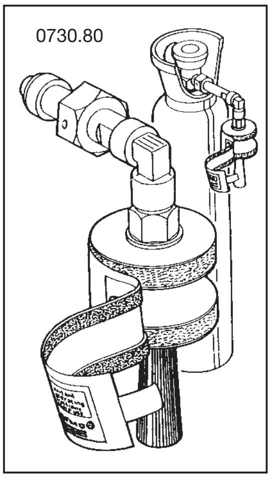
A) The effect of increasing radiation doses on plants.
B) That radiation is more harmful to some plants than to others.

Radioactive source

Americium-241 3,7 kBq. For use with diffusion cloud chamber no. 5120.00.

5105.05 Radioactive source
5105.10 Holder for 5105.05





Snowpack - apparatus for making dry ice

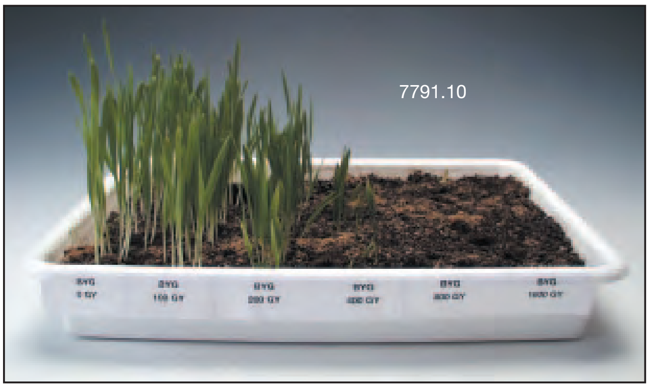
Connect the Snowpack to a siphon type CO_2 cylinder and proceed in accordance with the instructions. An injection time of 1 min. is sufficient to produce a diameter 50 x 22 mm pellet. The dry ice pellet may e.g. be used to operate the Diffusion Cloud Chamber.

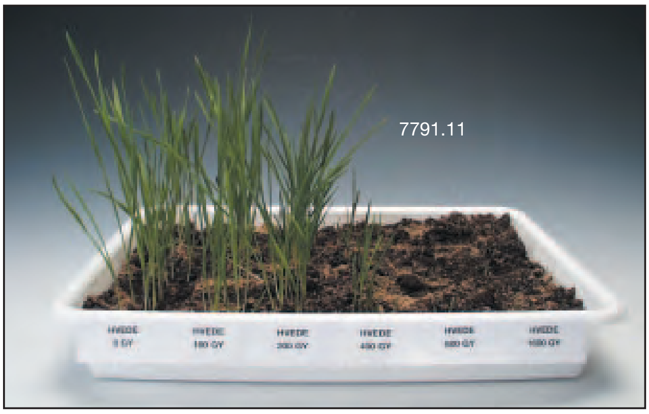
0730.80 Snowpack - apparatus for making dry ice

Sorting tray 35 x 27 cm

A plastic tray which can be used for a planting box for seedlings.

0520.30 Sorting tray 35 x 27 cm





Smoke chamber for brownian motion

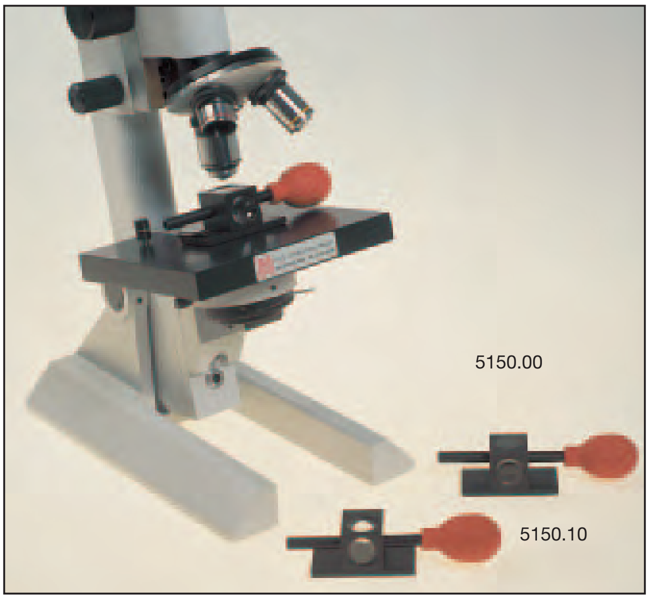
The chamber is designed for use with a microscope for showing brownian motion in smoke particles viewed through a microscope. An experiment lamp (or similar device) can be used as a light source. The apparatus is supplied with a convex lens which condenses the light inside the chamber. Smoke is drawn into the chamber with the aid of a squeegee. Size: 100 x 24 x 25 mm.

5150.00 Smoke chamber for brownian motion

Smoke chamber for brownian motion with laser

As item 5150.00 but for use with laser light. The apparatus is provided with two plane parallel windows which let the laser light pass through the chamber.
Size: 100 x 24 x 25 mm.

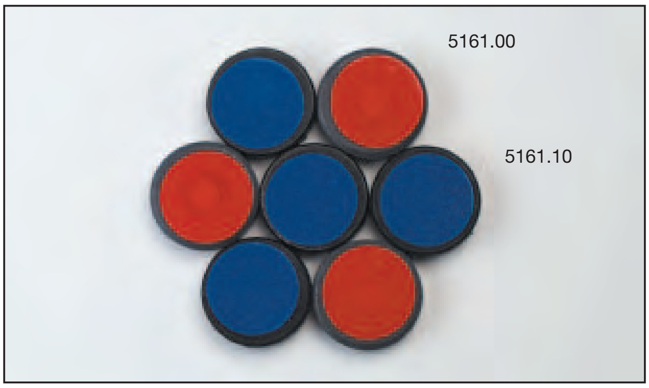
5150.10 Smoke chamber for brownian motion with laser

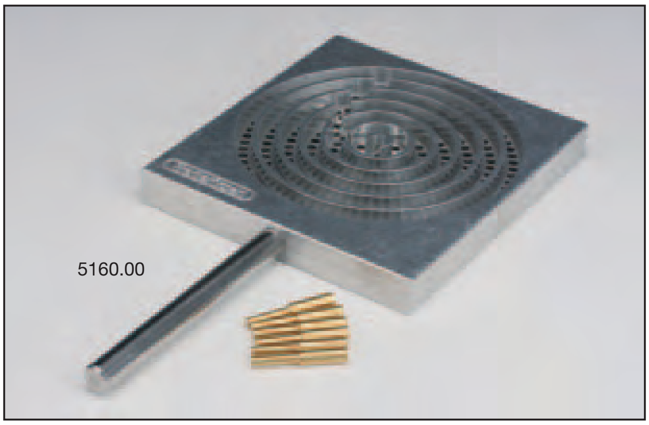


“Proton” and “Neutron” demonstration

This set is designed to demonstrate the stabilizing effect of neutrons on the atomic nucleus.
The “protons” are made of disc magnets while the “neutrons” are made of browned iron discs. The “protons” will, because they magnetized, repel one another when placed on a flat surface or overhead projector. The stabilizing effect of the “neutrons” is illustrated by placing them between the “protons”, thereby eliminating the repulsive force. The “protons” are supplied with a red marking, the “neutrons” with blue.

5161.00 “Proton” each
5161.10 “Neutron” each



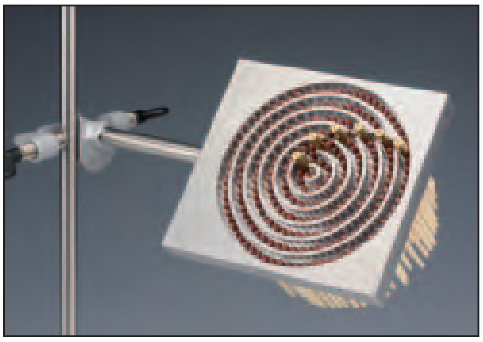


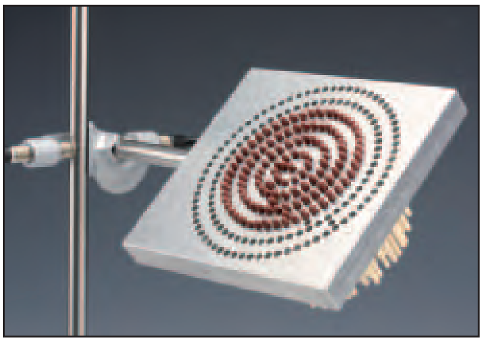
Chain reaction apparatus

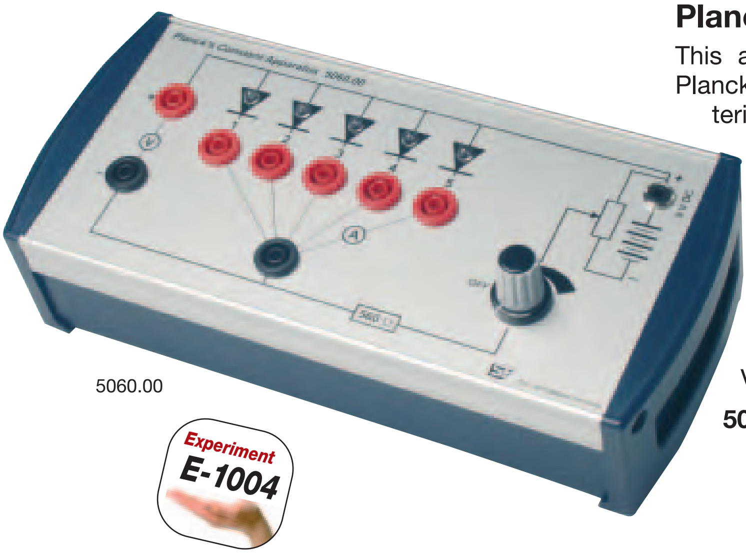
This item is used to demonstrate the chain reaction using matches. It is supplied with 6 ea. metal pins to show how a chain reaction can be damped.

5160.00 Chain reaction apparatus

5160.01 Extra metal pins for chain reaction apparatus, package of 6 ea.







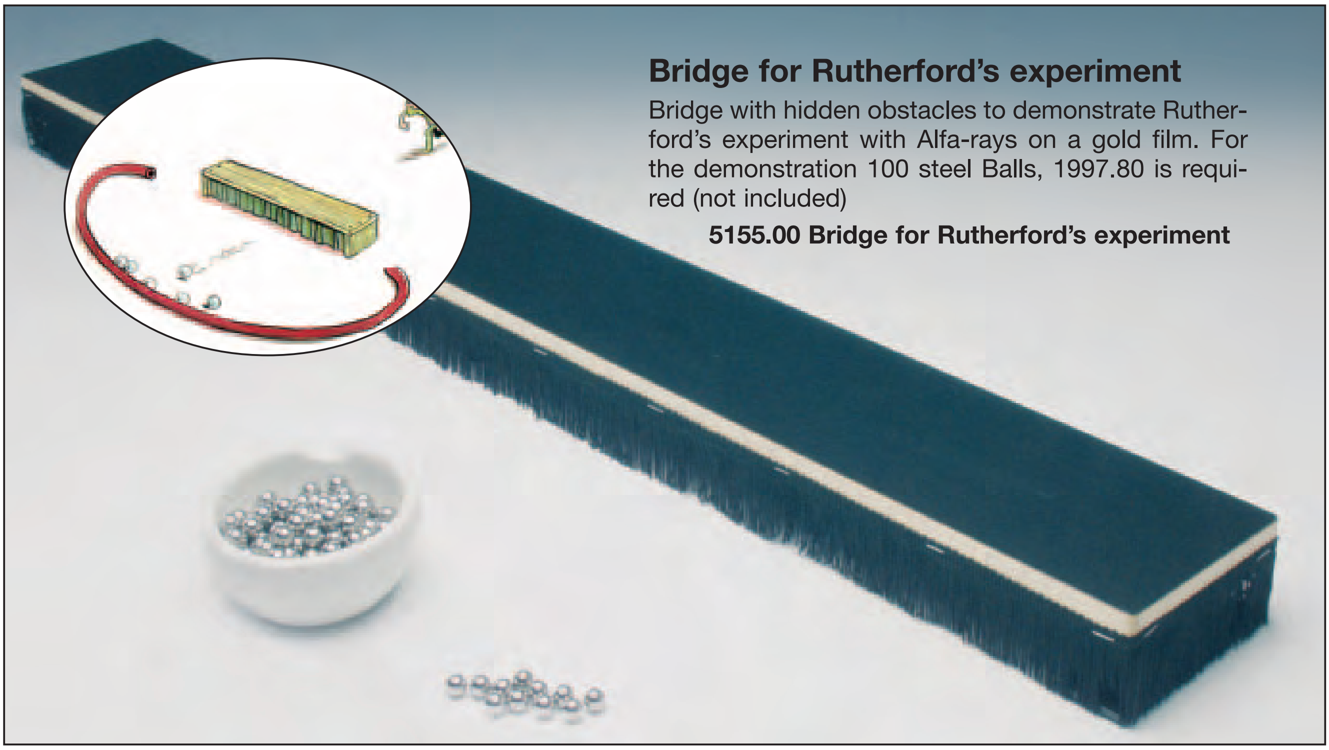
5060.00

Experiment
E-1004

Planck's constant

This apparatus is designed for the determination of Planck's constant using the elbow voltage in the characteristic curves of a number of light emitting diodes (LED's). The experiment is based on graphing the LED limit voltages as a function of the frequencies of the emitted light. The LED's used emit UV (ultraviolet), NIR (near infrared) and three wavelengths in the visible region. The LED's have been carefully selected to emit light within a narrow, well-defined wavelength interval. Either the built in 9 V block battery or an external 9-12 VDC line adapter can be used as power supply.

5060.00 Planck's constant



Bridge for Rutherford's experiment

Bridge with hidden obstacles to demonstrate Rutherford's experiment with Alfa-rays on a gold film. For the demonstration 100 steel Balls, 1997.80 is required (not included)

5155.00 Bridge for Rutherford's experiment

Electrophoresis apparatus

New electrophoresis apparatus with the possibility of water cooling to increase the speed of the experiment.

The electrophoresis apparatus is made of acrylic plastic.

The apparatus is provided with three support pads and a level for the adjustment of the apparatus.

The lid of the apparatus has been constructed in such a way that it is not possible to touch the high voltage parts while the apparatus is in use.

The connecting cables are supplied with safety jacks.

The electrophoresis apparatus is supplied with a tray and two combs with 4 mm and 8 mm teeth respectively for casting gels.

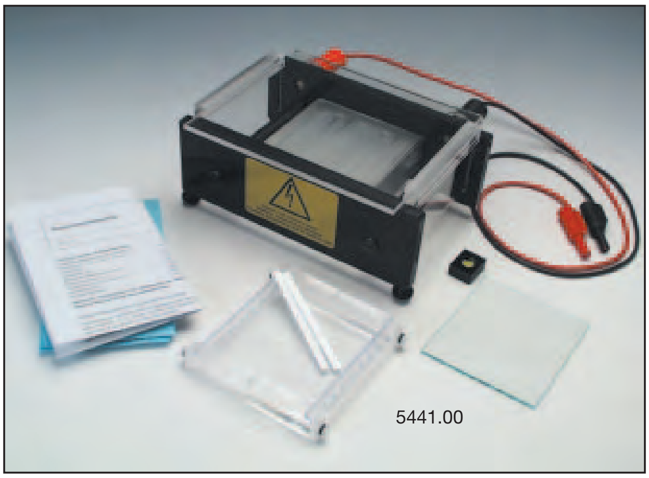
When the gel is to be cast, the edges of the tray are folded up, and a comb is placed at the place desired. When the gel is ready for use, the comb is removed, and the edges are pressed down. The tray with the gel is placed on the block in the middle of the electrophoresis apparatus.

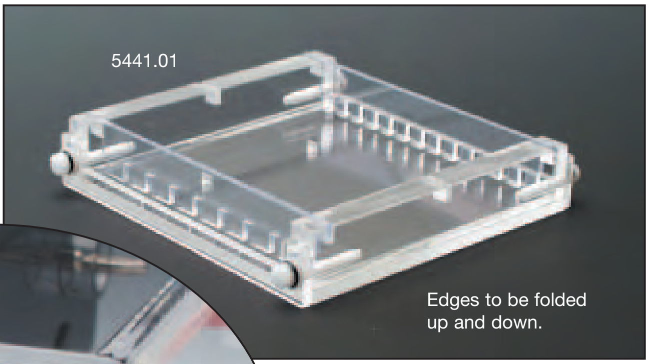
There are two electrode chambers for the buffer solution, a platinum electrode is present in each chamber. Between the chambers there is a container for the gel, under the glass plate of this container cold water can be added via two tube connectors.

Supplies with users manual and an experimental manual about colouring agents.

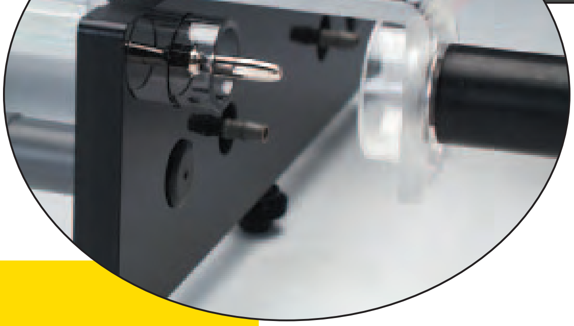
Dimensions: 210 x 160 x 80 mm. Mass: 1.7 kg.

5441.00 Electrophoresis apparatus





Edges to be folded up and down.



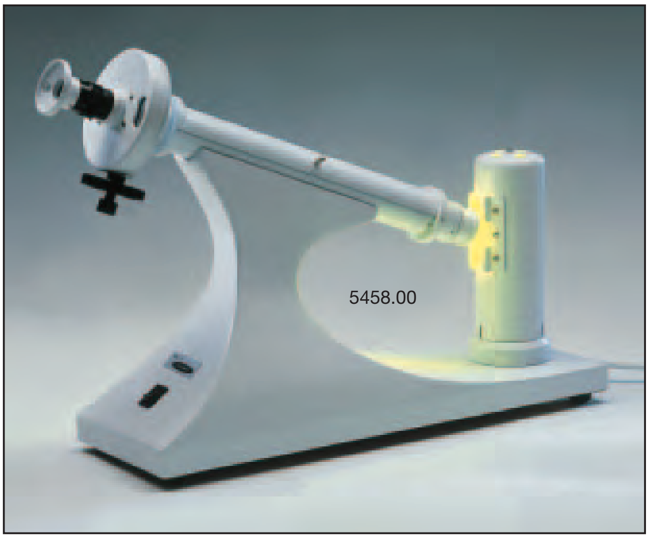
Tray for gelcasting

Extra tray for gelcasting, including one comb with 4 mm teeth.

5441.01 Tray for gelcasting

ADDITIONAL EQUIPMENT:

Power Supply 0-400 V DC 250 mA (5441.15)



Polarimeter

Polarimeter well suited to educational purposes. Used for determining the concentration of a known optical active compound in a solution, or determining the specific optical rotation of a compound in a solution. Fast, reliable and accurate measurements can be made with this instrument. The polarimeter is equipped with a scale from -180 degree to +180 degree, with a 1 degree scale and a nonius of 0,05 degree. Cuvettes as long as 200 mm can be used.

Supplied with:
1 Cuvette 100 mm
1 Cuvette 200 mm
1 Spare Sodium lamp
4 Spare test tube glass end pieces
10 Spare O-rings
1 Small screw driver
3 Spare fuses
1 Protective cover.
1 Users manual

5458.00 Polarimeter

5455.00

Spectrophotometer

This robust single-ray spectrophotometer covers the wavelength range from 190 to 1000 nanometers. Measurements of absorbance, transmittance and concentration are easy to perform. The desired measurement type is selected via the heavy-duty foil keyboard. The measurement type is indicated with LED's, and the wavelength interval is shown on a 3½ digit digital display. The result of the measurement is shown on a 4-digit display.
The spectrophotometer is supplied with a sled with room for 4 standard cuvettes so that 3 test samples can be inserted at once along with a reference sample. The instrument is supplied with 2 quartz cuvettes (for the UV) and 4 glass cuvettes. The spectrophotometer is equipped with an RS232 interface which makes it possible to perform measurements via a PC. A special facility permits scanning under PC-control, and experiments with reaction kinetics can also be performed. In addition it is of course possible to record standard graphs for determinations of concentration as well as individual measurements of absorbance and transmittance. A range of accessories are available, e.g. a flow-through cuvette and sleds designed for use with other cuvette types.

Items included as standard:

2 ea. quartz cuvettes
4 ea. glass cuvettes
User's Guide and Windows software for data collection

Technical specificaxtions:

Wavelength region:	190-1000 nm
Bandwidth:	5 nm
Wavelength accuracy:	+/- 2 nm
Wavelength reproducibility:	+/- 1 nm
Wavelength resolution:	1 nm
Measuring ranges:	0-125% T; 0-2.5 A; 0-1999 C
Light sources:	Tungsten halogen and deuterium lamps
Readout, results:	4 digit 13 mm LED display
Readout, wavelength:	3½ digit 13 mm LED display
Size:	47x40x14 cm. Mass: 12 kg
Power supply:	230/115 VAC selectable

5455.00 Spectrophotometer UV-2100

Peristaltic pump

- For titration-experiments
- In connection with column chromatography
- For dosage in connection with relay control

The pump works after peristaltic principles with 4 rolling steel cylinders that presses the liquid through the silicone tube.
The motor runs with constant speed at a certain voltage, so it is possible to change the speed by changing the voltage in the range 3-12 V, for short periods of time up to 24 V.
Pump capacity: 0-13 ml/min.
Dimensions: Height 101 mm, width 51 mm, depth 103, mass 340 g.

5480.00 Peristaltic pump

5480.00

pH/mV-meter M350, incl. electrode

Battery operated pH/mV-meter with digital Display. Easy to operate and provides fast and reliable results, with a reproducibility of 0,01pH. Adjustments for temperature and with puffers is easy made with simple turn-buttons. Well suited for field work. Comes with electrode, battery and English manual.

Specifications:

Range:	pH: 0,00 – 14,00
	mV: ± 1400
Accuracy:	pH: ± 0,01
	mV: ± 1
Input impedance:	> 1012 ø
Calibration range:	pH: ± 1 pH ved 25° C
	mV: ± 60
Temperature range:	0 – 100° C
Battery indicator:	Lo Bat - is shown on display
Display:	LC – display 3,5 digit 12 mm
Electrode bushing:	BNC
Battery/ lifetime:	9 V / > 200 timer
Dimension:	140 x 80 x 35 mm

5412.40 pH/mV-meter M350, incl. electrode

pH-Electrode

Standard pH electrode with a measuring range of 0-14. Complete with fixed cable and BNC connector. Comes with a protective cap and epoxy housing

5415.20 pH7-electrode, BNC

Compressed gasses

0755.10-.50
0760.00

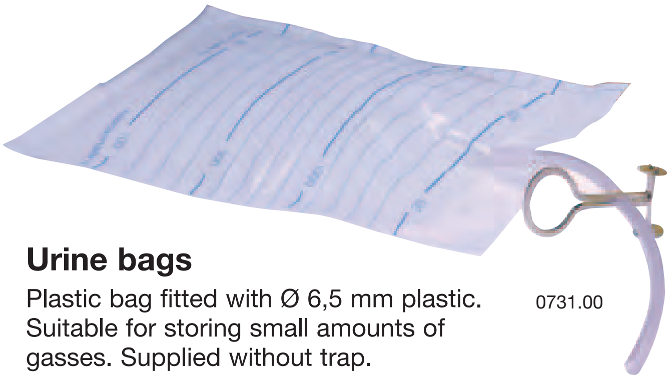
Compressed gasses in non-refillable flasks

Content: 14 l at atmospheric pressure.

No.	Compound	
0755.10	Oxygen	O2
0755.20	Nitrogen	N2
0755.30	Carbon dioxide	CO2
0755.40	Hydrogen	H2
0755.50	Helium	He

Necessary equipment:

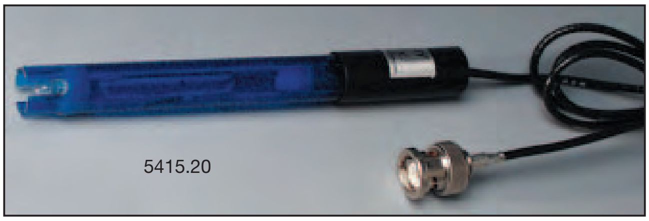
0760.00 Valve for non-refillable flasks



Urine bags

Plastic bag fitted with Ø 6,5 mm plastic. Suitable for storing small amounts of gasses. Supplied without trap.

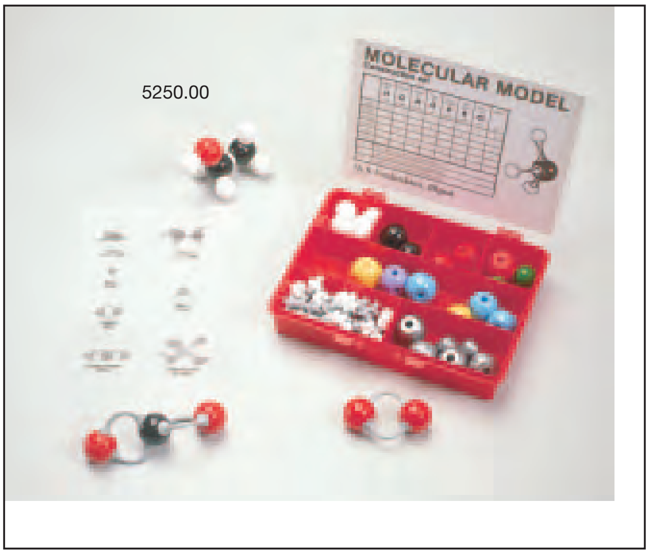
0731.00 Urine bags



Student molecular kit, inorganic

With this kit many compounds, both organic and inorganic, can be build. The kit comprise: 8 H-atoms (1 hole), 2 Cl-atoms (1 hole), 3 O-atoms (2 holes), 1 S-atom (2 holes), 1 S-atom (6 holes) 1 N-atom (3 holes), 2 N-atoms (5 holes), 2 C-atoms (4 holes), 1 P-atom (5 holes), 2 metal-atoms (1 hole), 1 metal-atoms (2 holes), 1 metal-atoms (3 holes), 1 metal-atoms (4 holes), 1 metal-atoms (5 holes), 14 short connections, 14 medium connections and 7 long flexible connections. Supplied in a convenient storage box, with a hinged lid.

5250.00 Student molecular kit, organic/inorganic

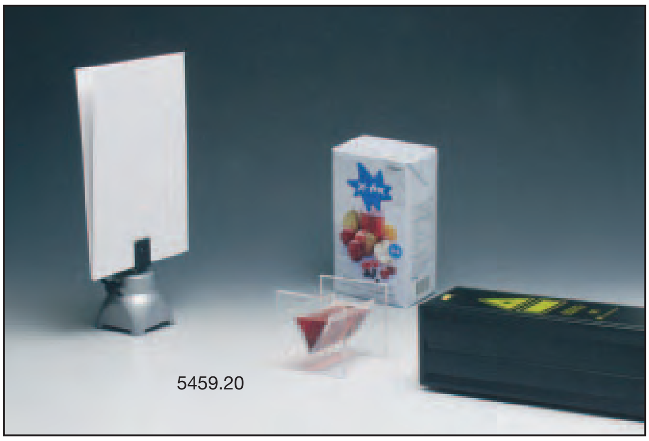

5250.00

Student molecular kit, organic

With this kit many organic compounds can be build. The kit comprise: 12 H-atoms (1 hole), 6 O-atoms (2 holes), 3 N-atom (3 holes), 6 C-atoms (4 holes), 15 medium connections and 15 long flexible connections. Supplied in a convenient storage box, with a hinged lid.

5250.10 Student molecular kit, organic

5250.10
Molekylebygger


5459.20

Sugar prism

This simple apparatus provides a simple method for computing the sugar concentration in liquids, e.g. soda pop. Using a number of reference solutions with known sugar content one can compare the refraction of light, e.g. a laser beam, of reference samples and an unknown solution. Supplied with complete instructions for student projects and experiments.

5459.20 Sugar prism

Laser pointer

Easy to use pencil sized diode laser pointer. Run on batteries. Works well when experimenting with refraction of light in various materials.
Wavelength: 670 nm.
Power: < 1 mW (class II).
Beamdivergence v/22m: Diameter < 27 mm.

1420.70 Laser pointer

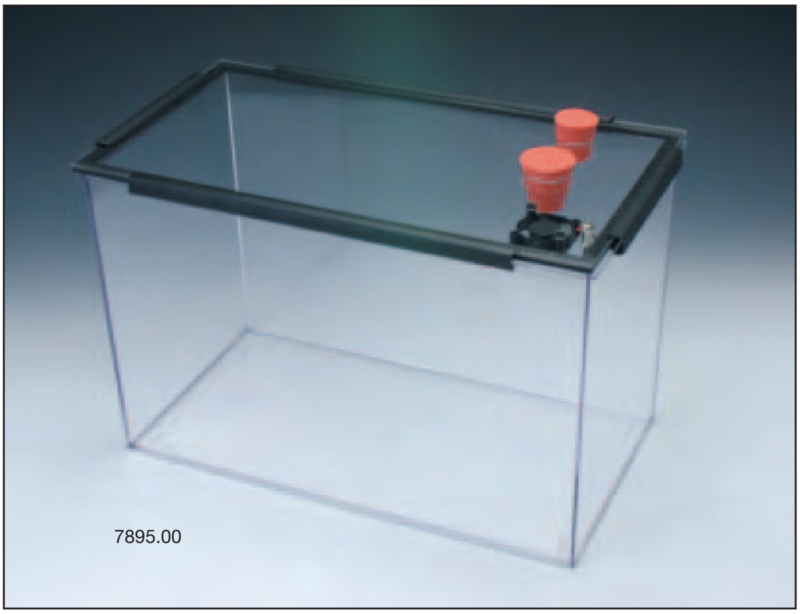
1420.70
Laser Pointer

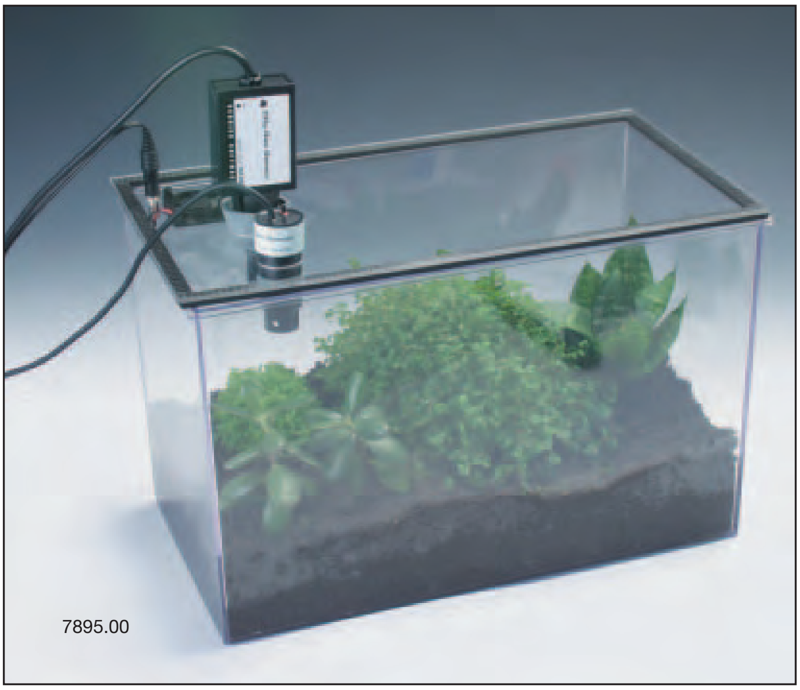
Worm container

This item is a clear vertically standing plastic container with glass sidewalls for studying the behaviour of worms and other small creatures with soil as their habitat. The container can be filled with alternating layers of sand and soil. The end surfaces are made of clear plastic. The sides are made of glass, and one of these can be removed for easy cleaning.
Size: 30 x 20 x 5 cm. Supplied with an opaque cover so that the container can be stored in the dark.

7675.10 Worm container

7675.10


7895.00


7895.00

Garden in a bottle

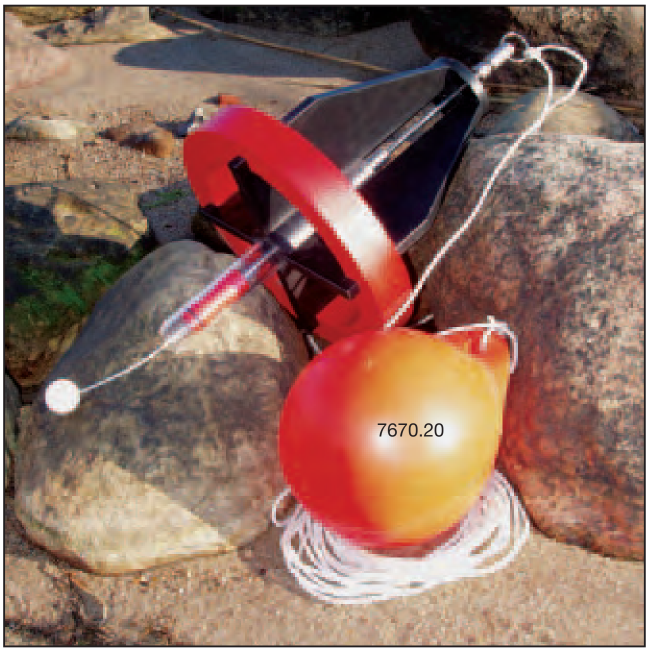
The “garden in a bottle” consists of a plastic aquarium with a lid. Plants and/or animals are placed in the container to which probes (e.g. oxygen probe 3886.70 or carbon dioxide 3886.10) can be mounted. Changes in the oxygen and carbon dioxide content of the atmosphere within the container can then be followed. A ventilator is mounted in the lid. It can be connected to an electrical outlet using a power supply or an AC/DC adapter. Stoppers are supplied which can be used to seal openings which are not in use.

7895.00 Garden in a bottle

Collecting cuvette

For studying and photographing minor animals from fresh- or salt water. No corners where the small animals can hide. Made of acrylic. Dimensions: 9 x 11 x2,5 cm.

7615.50 Collecting cuvette

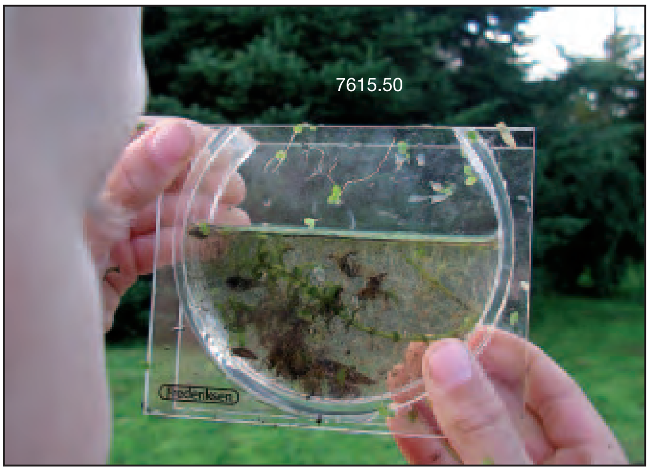


Bottom sample collector

Bottom Sample Collector for collecting quantitative bottom samples for analyzing organic matter, nutrition salts, sediment composition and micro-organisms. Sturdy design with a very heavy lead-ring, tube and tube-holder and piston made of strong plastic, and pole of stainless steel. Both tube and pole is adjustable, allowing for variations in depth of sample. Supplied with a strong cord (10 m) and float.
Outer dimension: Dia. 200 mm x H 460 mm, Dimension of test tube: Dia. 18 mm x max 150 mm.
Weight: 5,5 kg.

7670.20 Bottom sample collector

5459.10
5459.00



Irradiated plastic kit

Kit with various plastic types, illustrating their different properties.
Kit comprises: Irradiated and not-irradiated PE-rods; Irradiated and not-irradiated PE-spheres, PVC-tubing, heat shrink tubes and dry artificial sponges.

5820.00 Irradiated plastic kit

Hand-held refractometer

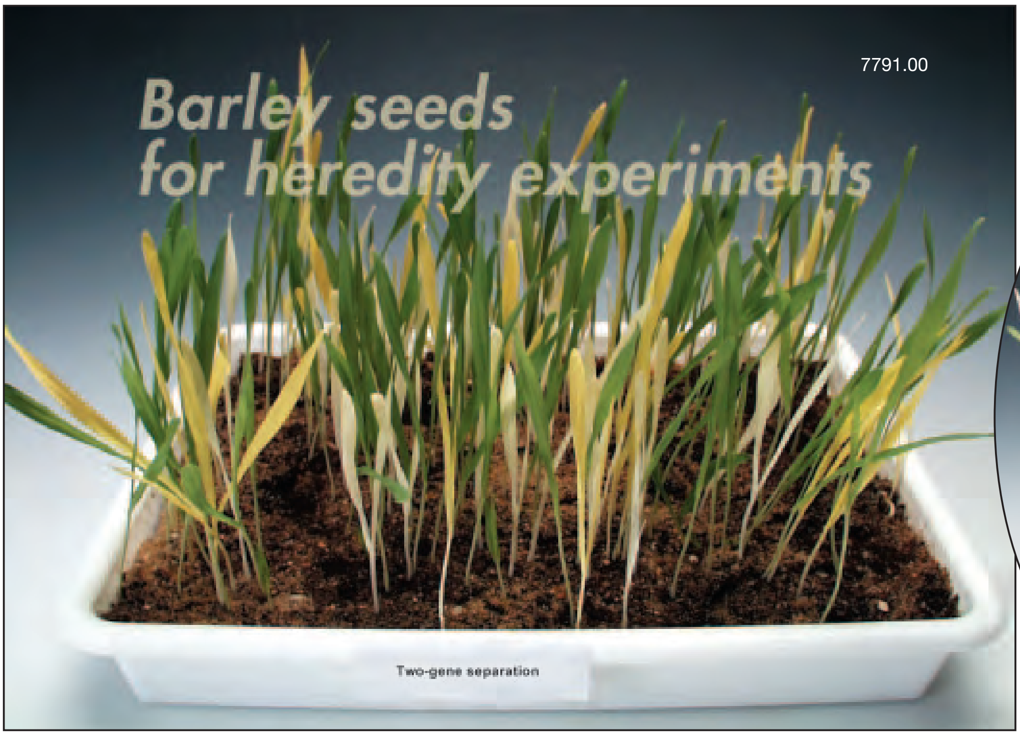
This device can measure sugar concentrations in the range 0-32%. A few drops is enough to perform a measurement, and the result can be read at once. The scale is calibrated for sugar concentration because this is of interest in testing of fruit juice, marmelade, wine, etc. Supplied with calibration adjustment screw.
Scale resolution: 0.2%.
Length: 170 cm. Diameter: 27 mm. Mass: 176 g.

5459.00 Hand-held refractometer, 0-32%

Hand-held refractometer

This device can measure sugar concentrations in the range 0-80%. Liquid honey has about 80% sugar concentration. Supplied with calibration adjustment screw. Scale resolution: 0.2%. Length: 155 cm. Diameter: 30 mm. Mass: 190 g.

5459.10 Hand-held refractometer, 0-80%



7791.05
7630.00
Albina

Simple plant experiments for demonstration of the laws of genetics

Two-gene separation 9:3:4 in barley

The barley seeds are heterozygotic (genotype AaBb) for two recessive, non-coupled genes.
In the experiment the presence of two different mutant genes in parley is shown: Albina (white chlorophyll mutation) and Xanta (yellow chlorophyll mutation).
When the seeds are planted the separation ratio 3:1 is observed for each of the two recessive genes.
At the same time the fenotypes green, yellow and white are observed in the ratio 9:3:4 for both of the two recessive, non-coupled genes as a whole.
The seeds are planted in a planting box e.g. no. 0520.30.
The material is placed in a bright area such as a window sill for sprouting. After 6 to 10 days the number of (kim) plants with the three different fenotypes green, yellow and white can be counted. The separation ration is computed and compared with the expected result. A χ^2 test can be used if desired.
Supplied in a bag with about 200 seeds and instructions.

7791.00 Two-gene separation 9:3:4 in barley

Chlorophyl mutations in barley

The material includes seeds of three barley lines, Albina (white chlorophyl mutation), Viridis (light green chlorophyl mutation) and Xanta (yellow chlorophyl mutation), each with a recessive mutant gene. The barley seeds are heterozygothic for just this gene.
When growing the seeds the separation ratio 3:1 will be observed for each of the three barley lines.
The seeds are sown in flower pots e.g. no. 7630.00 or planting boxes e.g. no. 0520.30.
Albina, Viridis and Xanta-a can be set to sprout on a bright window sill. Xanta-b and Xanta-c are germinated in the dark to show the relationship between heredity and environment.
After 6-10 days the material is ready for observation. Xanta-b should be placed in a bright place the day before.
The number of sprouts with the various fenotypes are counted and compared with the expected result.

The following is supplied:

1 bag with about 40 Albina seeds.
1 bag with about 40 Viridis seeds.
1 bag with about 120 Xanta seeds + instructions.

7791.05 Chlorophyl mutations in barley

Irradiated seeds

Simple plant experiments for demonstration of the effect of radiation on plants

With this experiment the effects of increasing radiation doses on plants can be observed. It will also be found that radiation is more harmful to some plants than to others.

Five different types of irradiated seeds can be supplied: barley, wheat, rapeseed, flax and yellow mustard.

The seeds are supplied in sets with 6 different radiation dosages: 0 kilorad, 10 kilorad, 40 kilorad, 80 kilorad and 160 kilorad with about 40 seeds for each dosage.

The gamma irradiated seeds are not radioactive, so the experiments with them are completely safe.

The seeds are sown in short rows in a planting box e.g. no. 0520.30. The material is placed in a bright window sill to germinate. The plants should begin to sprout within 7 to 12 days depending upon the seed type and the temperature. The height of the plant corresponding to each radiation dose can be measured and compared. The effect of different radiation doses on plant growth can also be studied.

Supplied with instructions.

7791.10 6 x 40 Barley seeds
7791.11 6 x 40 Wheat seeds
7791.12 6 x 40 Rape seeds
7791.13 6 x 40 Flax seeds
7791.14 6 x 40 Yellow mustard seeds
7791.20 Set with all 5 seed types

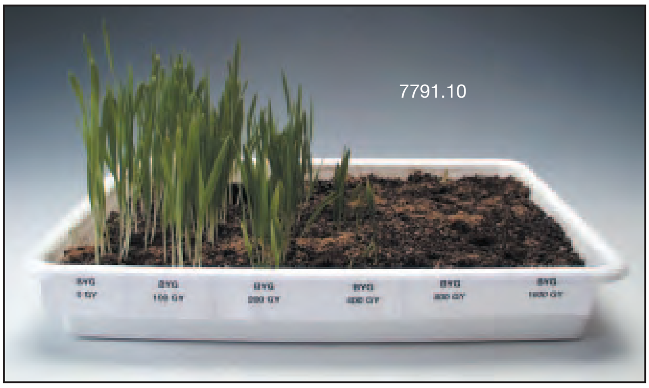
This experiment shows:

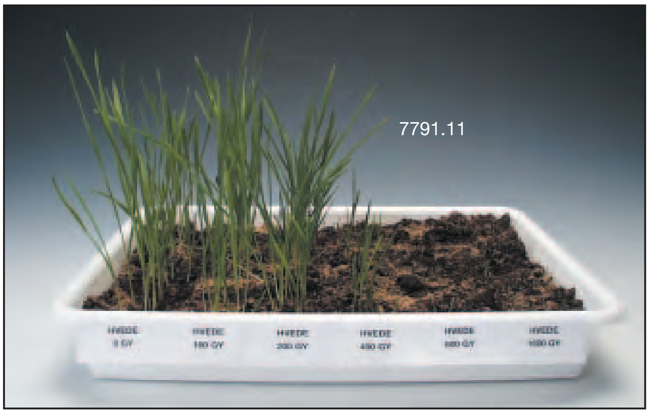
A) The effect of increasing radiation doses on plants.
B) That radiation is more harmful to some plants than to others.

Sorting tray 35 x 27 cm

A plastic tray which can be used for a planting box for seedlings.

0520.30 Sorting Tray 35 x 27 cm





Protein experiment – lysine variants at barley

A chemical, genetically and biochemical investigation

The background for the experiment is that Lysine is an essential amino acid, important for utilization of other amino acids. Barley is poor in Lysine, so more lysine-rich components is added food for farm animals. Barley with an increased amount of Lysine have been breeded. The purpose of the experiment is to investigate the Lysine content in various barley-types .

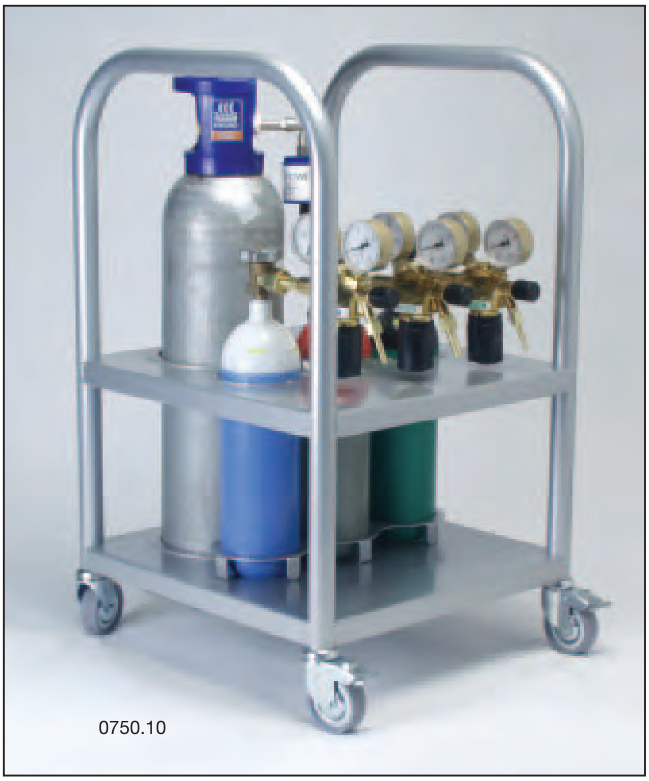
A kit comprises the following material:

1 Barley strand of a normal barley, type Bomi, genotype LYS3LYS3

1 Barley strand of a RI 1508 Barley, genotype lys3lys3

4 Barley strands of a plant, heterozygotic for Ri 1508, genotype LUS3lys3.

7791.30 Protein experiment - lysine variants at barley



Trolley for compressed gases

Trolley witch fit 2 2-liter and one 6-liter steel Flasks of compressed Gasses. Made of enamelled steel and equipped with rubber wheels.

0750.10 Trolley for compressed gases

Protective screen

Acrylic Screen, 880 x 600 x 6 mm. Fitted with two chrome plated pins that fits two bushings (enclosed) which are to be fitted to a table.

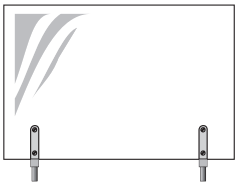
0840.10 Protective screen

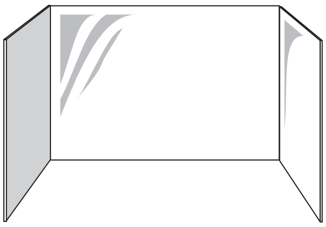
Protective screen

Three-sided protective Screen, 880 x 600 x 6 mm, with two sides, each 440 x 600 x 6 mm mounted on higes. Thise protective Screen is self-carrying and can easily be placed anywhere.

0840.20 Protective screen

0840.10





0840.20

Personal face screen

Made of unbreakable clear plastic, fitted with a metal Fringe. Fitted on a Holder for the Head.

0845.00 Personal face screen

Personal safety goggles

Made of unbreakable clear plastic. Can be used over glasses.

0850.00 Personal safety goggles

Apron

Strong apron made of plastic covered linen. Size: 68 x 90 cm.

0855.25 Apron

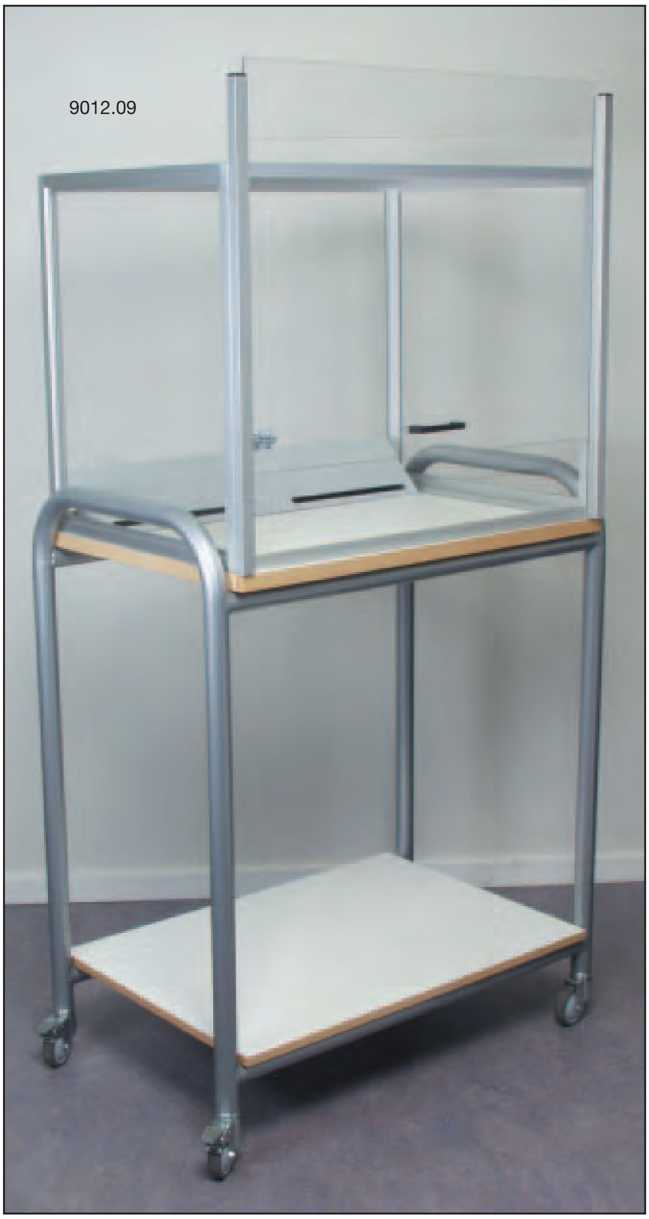
Portable fume hood

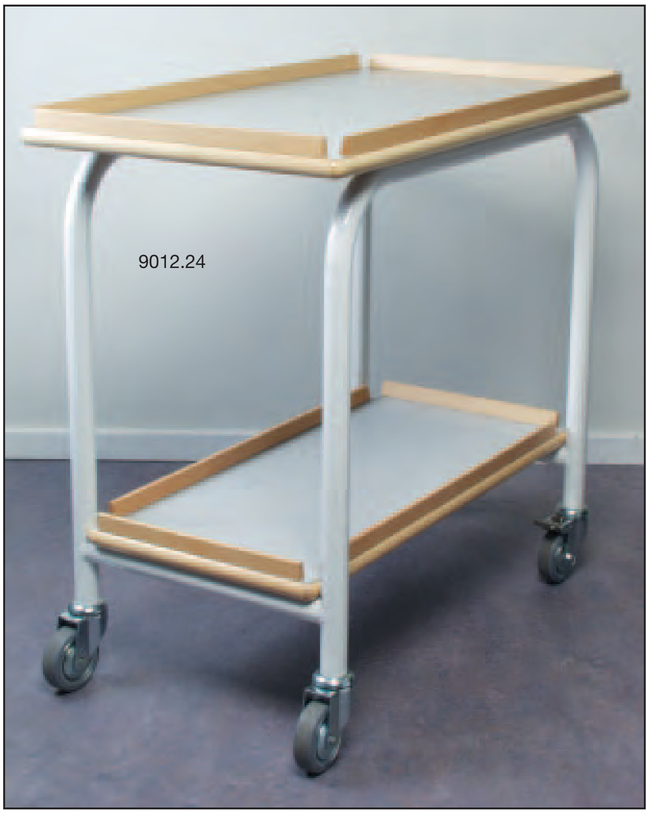
A simple hood, which gives the opportunity of establishing temporally evacuation. Must be connected to existing ventilation. Connecting hose and ventilator is not included.

Technical data:

Trolley: Made of Ø38 mm enamelled steed tubes, fitted with 4 rubber Wheels, of which 2 can be locked. Upper and lower table measures 79,5 x 56 cm. The upper table has a heat resistant surface, and is mounted 97,5 cm above the floor.
Hood: Made of clear acrylic fitting the upper table. One full side makes up the slide-able front. The actual evacuation is made through a panel at the lower rear end of the hood. This panel is fitted with a hose through the upper table, where connection to ventilation is made.

9012.09 Portable fume hood





Lab trolley

Lab Trolley with two tables. A lower table, 86 x 41 cm, and an upper table, 95 x 54 cm. The tables is fitted with sides to prevent equipment from rolling to the floor.
Height of upper table: 86 cm. The frame is made of Ø38 mm enamelled steed tubes, fitted with 4 rubber wheels, of which 2 can be locked.

9012.24 Lab trolley

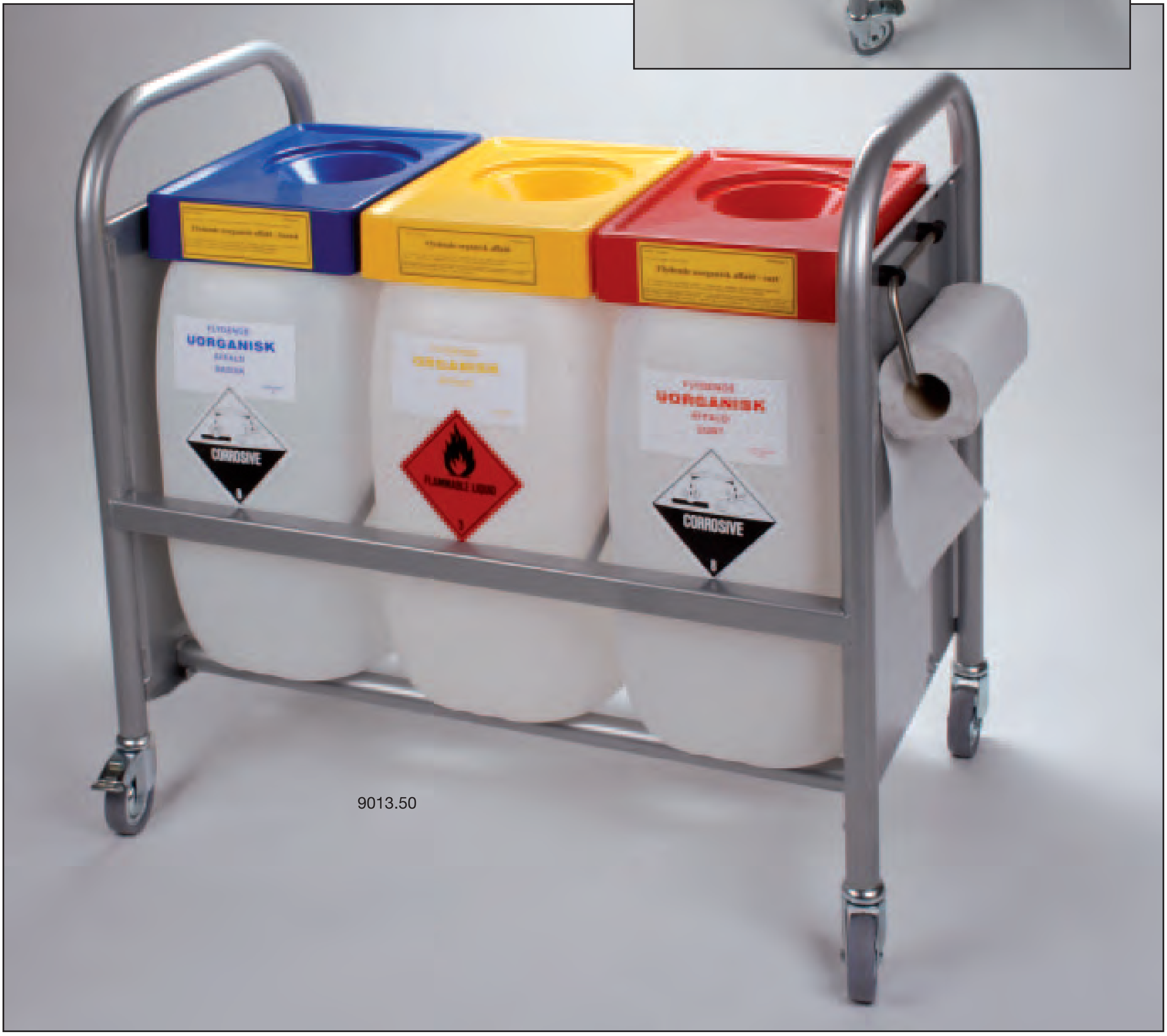
Waste trolley

Trolley with 3 large (25 l) plastic containers for liquid waste, one trash bin for common waste and a holder for a roll of paper towels. Trolley made of Ø38 mm enamelled steed tubes, fitted with 4 rubber Wheels, of which 2 can be locked. Comes with plastic containers, trash bin and labels for containers.

9013.50 Waste trolley

Spare parts:

0539.00 Plastic container with lid, 25 l
9013.55 Waste bin with lid



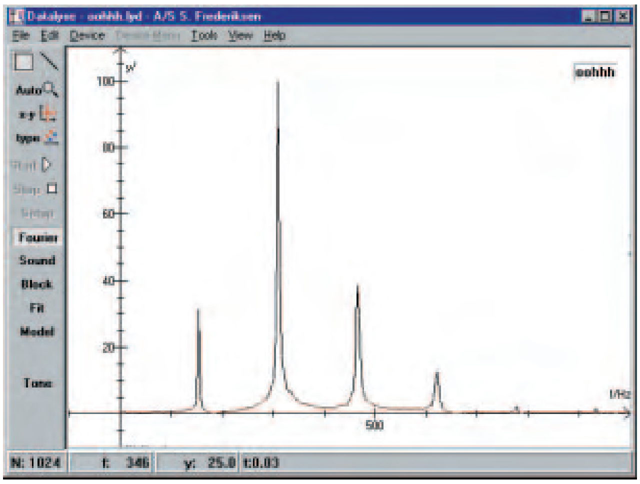
9013.50

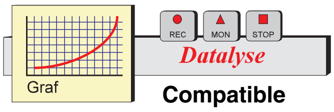
Computer program Datalyse

This data collection program is designed for use with equipment with RS-232 output options. The program also includes a range of standard functions for data handling and a graphics module for graphical display of the collected data.
The program contains data collection options for other measuring instruments as well and can be a valuable teaching aid when working with RS-232 compatible equipment.

Freeware

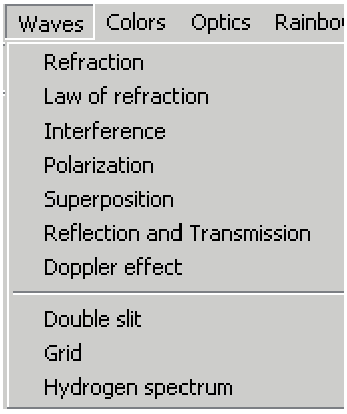
All equipment descriptions bearing this mark indicate that the equipment is supported by the program "Datalyse".

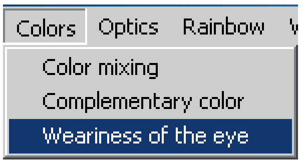

Datalyse - oohhh.lyd - A/S S. Frederiksen
File Edit Device Tools View Help
Auto
x-y
type
Start
Stop
Setup
Fourier
Sound
Block
Fit
Model
Tone
100
80
60
40
20
500
f/Hz
oohhh
N: 1024
f: 346
y: 25.0 t:0.03

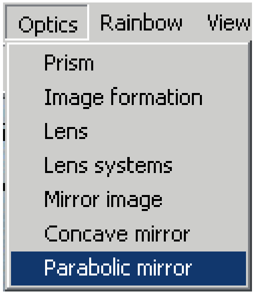

Graf
REC
MON
STOP
Datalyse
Compatible

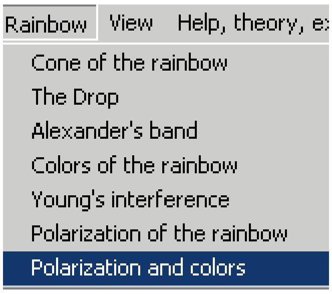
Rainbow – a simulation program for Windows

The content is quite broad, and the user (student) is encourage to explore the various topics.
The program covers four main areas:


Waves
Colors
Optics
Rainbo
Refraction
Law of refraction
Interference
Polarization
Superposition
Reflection and Transmission
Doppler effect
Double slit
Grid
Hydrogen spectrum

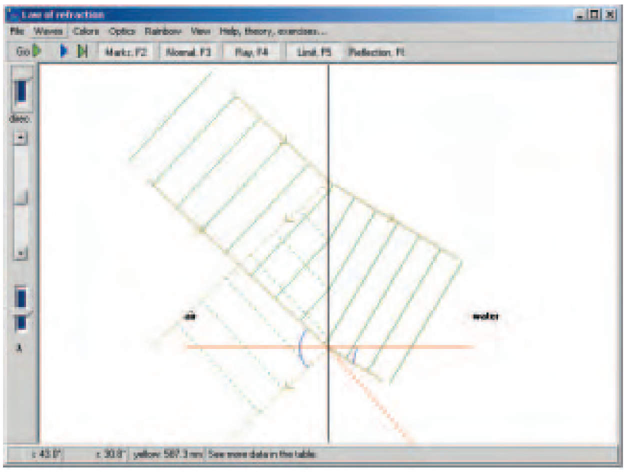

Colors
Optics
Rainbow
Color mixing
Complementary color
Weariness of the eye


Optics
Rainbow
View
Prism
Image formation
Lens
Lens systems
Mirror image
Concave mirror
Parabolic mirror


Rainbow
View
Help, theory, e
Cone of the rainbow
The Drop
Alexander's band
Colors of the rainbow
Young's interference
Polarization of the rainbow
Polarization and colors

Waves, Colors, Optics and The rainbow, each of which containing a broad array of animations with the option of changing various parameters which affect the processes under study. Parameters include: wavelengths, indices of refraction, lens and prism materials, angles of incident of light rays, radii of curvature for lenses and much more.

Freeware


Law of refraction
File Waves Colors Optics Rainbow View Help, theory, exercises...
Go
Marks F2
Normal F3
Ray F4
Limit F5
Reflection F6
air
water

Both of these recommendable programs are deveoped by Carl Hemmingsen, and can be downloaded FOR FREE at www.datalyse.dk

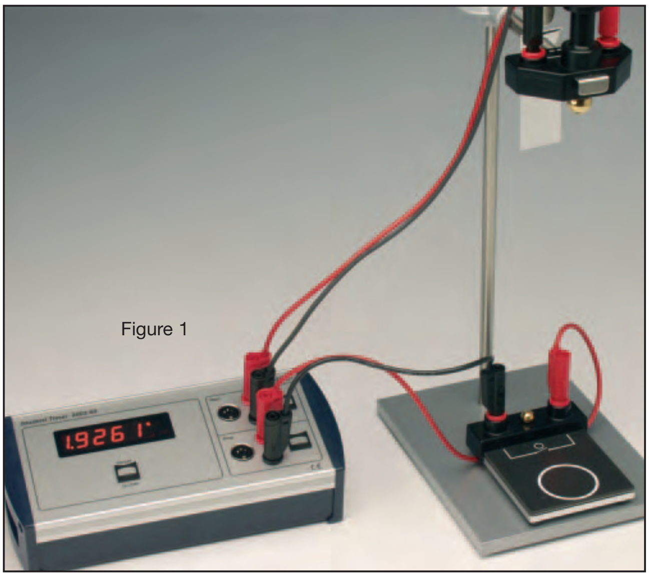


Figure 1

Purpose

The goal of this experiment is to determine the acceleration of gravity g.

Experimental setup

Measurements of corresponding values of fall time and height permit the determination of the acceleration of gravity using the equation:

$$g = \frac{2 \cdot s}{t^2}$$

Procedure

The experimental setup is shown in Figure 1.

- Position the strike plate directly under the release mechanism.
- Cock the release mechanism (1) (Figure 2)
- Place the steel ball in the depression (5) between the contact plates (4) on the release mechanism.
- Release the steel ball using the push button (3). The timer starts.
- When the steel ball hits the strike plate, the timer stops.
- The fall height s is measured using a ruler as the distance from the lower edge of the ball (when ready for release) to the upper surface of the strike plate. Parallax error can be avoided by using the mirror provided.
- The experiment should be repeated using various values of the fall height, and corresponding values of height and time should be noted, e.g. by typing them directly into an Excel spreadsheet. It is then a simple matter to compute values of the acceleration of gravity.

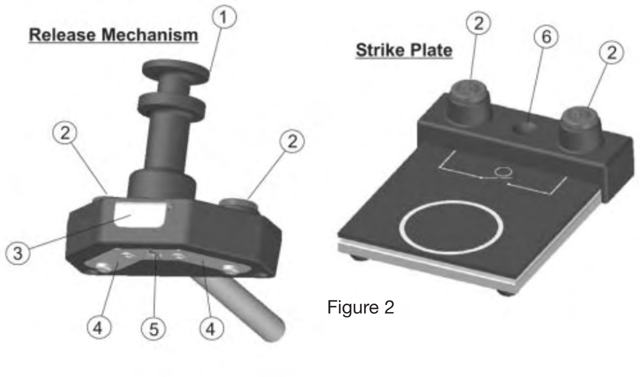


Figure 2

In order to ensure as good an electrical contact as possible the contact plates and the steel ball are gold plated, and they should be kept perfectly clean. They can be cleaned using an organic solvent such as alcohol. Thin cotton gloves can be used to avoid problems due to sweat from fingers and hands.

Height, s	Time, t	$g = \frac{2 \cdot s}{t^2}$

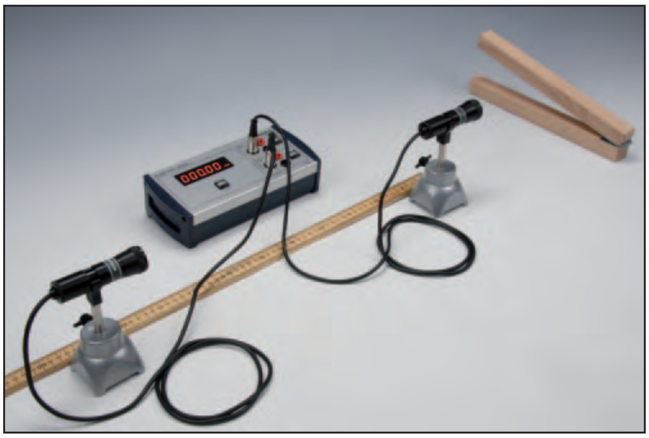
Required Equipment

1980.10	Free Fall Apparatus	1 pcs.
2002.60	Student timer or equiv.	1 pcs.
Retort stand and cables		

The speed of sound

Purpose:

To measure the speed of sound in air



Experimental setup:

Knowing the distance between two microphones and the time required for a sound wave to pass from one to the other, the propagation speed of sound can be found using the equation

$$v = \frac{s}{t}$$

The speed of sound in dry air is actually depending on the temperature, thus

$$v_{dry-air} = 331.3\,\tfrac{m}{s} + 0.606\,\tfrac{m}{s\,°C} \cdot T_C$$

Where T_C is the temperature in Celsius.

Procedure:

1) The microphones are placed in line with the sound source, so that a sound pulse will pass the first microphone and then the second. It is often practical to let this distance equal one meter.
2) The microphones are connected to the timer unit so that the front microphone is connected to ”start”, and the second microphone is connected to ”stop”.
3) The timer unit is turned on. Then a clapper board is used to make a sharp sound about a meter from the front microphone and in line with the pair.
4) When the sound pulse passes by the first microphone it will cause the timer to start, and when it passes the second microphone, it will cause the timer to stop.
5) Make a note of corresponding values of the distance between the microphones and the time for the pulse to travel from one to the other. I can be convenient to repeat the experiment with the microphones at a fixed distance to ensure that the same result is obtained each time. An average of ten good repeats will yield good results.
6) It can also be instructive to draw a graph with the distance between the microphones on the y-axis and the transit time on the x-axis. The slope of the best straight line through these points will then correspond to the speed of sound.

Time, t	Distance, s	$v = \frac{s}{t}$

Remarks

If unexpectedly short time intervals are measured (around 1% of the expected value), this is generally due to the sharp clap sounds being too loud. Move slightly away from the microphones and try again until consistently good measurements are obtained. Practice makes perfect!

If the timer shows very long time intervals, this is most often due to an imprecise sound pulse which does not provide the microphones with clear start and stop signals. Try again using a sharper, louder sound pulse.

Required Equipment

2002.60	Student timer or equiv.	1 pcs.
2485.10	Microphone	2 pcs.
2482.00	Clapper board	1 pcs.

Boyles law – pressure and volume of an ideal gas

Purpose

The goal of this experiment is to illustrate the relationship between the volume and pressure of an ideal gas at constant temperature.

Theory

The behaviour of an ideal gas at constant temperature can be expressed as follows:

$$p \cdot V = K$$

where p is the pressure of the gas, V is it's volume and K is a constant which remains the same for a given quantity of gas at constant temperature. During the experiment corresponding values of p and V will be noted, and the constant K can be found.

Procedure

1) Open the air release valve. The air pressure can be read on the scale (in this case 10 newtons per square centimeter).
2) Adjust the front edge of the piston so that it is in line with the middle scale marking. Now close the air re–lease valve. Compress the trapped air using the piston until the volume is halved. Note that the pressure has increase to 20 N/cm^2.
3) Now open the air release valve and adjust the piston so that its front edge again flush with the middle scale marking. Close the air release valve. Pull the piston outwards until the volume of the trapped air is doubled. Observe that the pressure has fallen to 5 N/cm^2.
4) Note the corresponding values of the volume and the pressure. The constant K can now be computed.

According to Boyle's law all the values of K should be the same. Small deviations are acceptable.

The above procedure is appropriate to a classroom demonstration. In the laboratory you may wish to take a larger number of measurements (e.g. about 8 or 10) so that there will be more data to work with.

Remarks

The piston should not be pressed with so much force that the pressure exceeds 25 N/cm^2, because the manometer calibration may be altered. Excessive force will ruin the instrument.

If the experiments are performed very rapidly, the effects of temperature changes (temperature increase during compression, temperature drop during expansion) can be observed. E.g. if the pressure is halved very quickly, the air in the cylinder will be heated slightly (just as is observed when you pump your bicycle tire). Before the air cools the pressure may reach 22 N/cm^2. But the air quickly cools off so the assumption of constant temperature is fulfilled, and the pressure will drop to the Boyle's law value of 20 N/cm^2.

Required Equipment

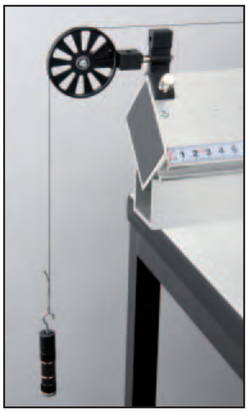
1805.00	Boyle Mariotte Apparatus	1 pcs.

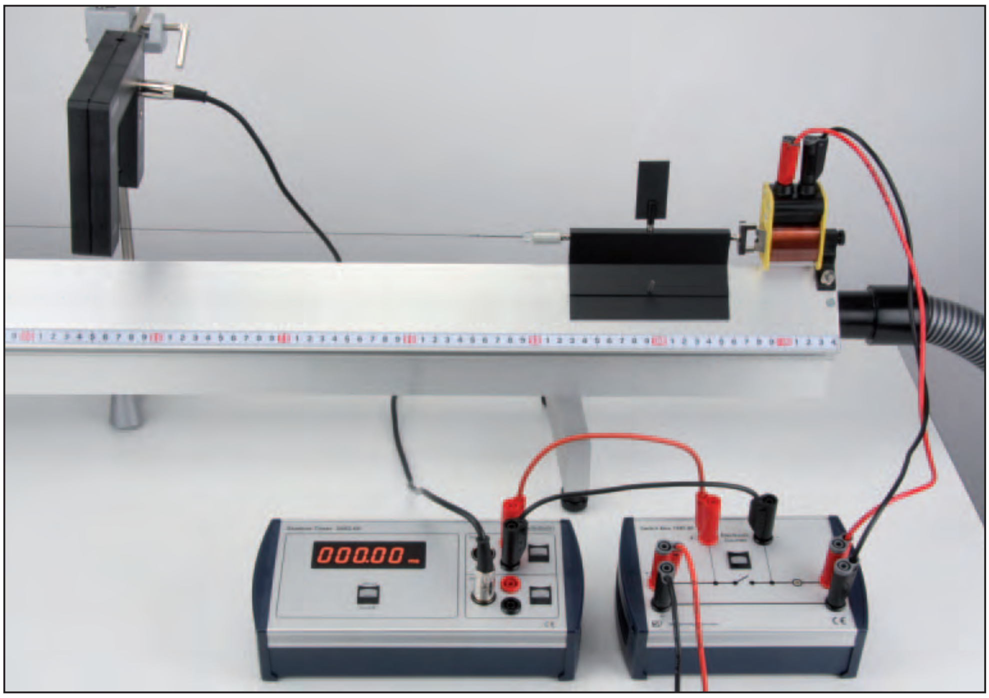
Newton's 2nd Law of Motion

Purpose

The goal of this experiment is to illustrate Newton's 2nd Law of Motion

$$F = m \cdot a$$





Theory

The relationship between position s and time t for linear motion with constant acceleration is:

$$s = s_0 + v_0 \cdot t + \tfrac{1}{2} \cdot a \cdot t^2$$

For motion on an air track where the air track glider is initially at rest v_0 and s_0 can be set equal to zero. In this case the equation may be reduced to:

$$s = \tfrac{1}{2} \cdot a \cdot t^2$$

By measuring corresponding values of s and t the acceleration *a* can be found. This can be done by plotting the values in a coordinate system with t^2 as the abscisse and s as the ordinate. For such a graph the acceleration a equals twice the slope of the best straight line through the data points.

Newton's 2nd Law of Motion asserts that the force exerted on an object equals the product of its mass and acceleration.

$$F = m \cdot a$$

Comparing this to our experiment the force exerted on the air track glider is the pulling force F_W exerted by the small pulling weights.

$$F_w = m_w \cdot g$$

Where m_W is the weight of the weights and g is the acceleration due to gravity, g = 9.82 m/s^2

Using F_w as the force F in Newton's 2nd Law of Motion, we can calculate the expected acceleration on the glider. By comparing this to the one determined by the experiment, Newton's second law of motion can be demonstrated.

Procedure

1) Prepare the setup as shown, where the switch box will start the counter and the photocell will stop it.
2) Repeat the experiment for various acceleration distances by moving the photocell gate back and forth on the air track. Measure corresponding values of s and t.
3) The acceleration can be determined in one of two ways:
   a) Calculate the acceleration in each experiment from the formula
   $$a = \frac{2 \cdot s}{t^2}$$
   b) Plot the values in a coordinate system with t^2 as the abscisse and s as the ordinate.
   The average acceleration of the airtrack glider in the experiments can be found as twice the slope of the best straight line through the data points
4) The expected accelleration of the glider is found by solving
$$m_w \cdot g = (m_w + m_{glider}) \cdot a$$
giving
$$a = \frac{m_w \cdot g}{m_w + m_{glider}}$$
5) Compare the acceleration determined in the experiment with the expected acceleration found according to Newton's 2nd Law of Motion

Position s	Time t	Acceleration	
		measured $a = \frac{2 \cdot s}{t^2}$	expected $a = \frac{m_w \cdot g}{m_w + m_{glider}}$
0,5 m			
1,0 m			
1,5 m			

Remarks

Notice that it is very important to measure s correctly. This is done by measuring the distance between the leading edge of the flag on the air track glider and the middle of the photocell.
In this experiment the switch box is used to hold and let go of the glider. If the air track firing mechanism (a rubber band holder) is used, then the air track glider will have an initial speed v_0 and the equation of motion becomes

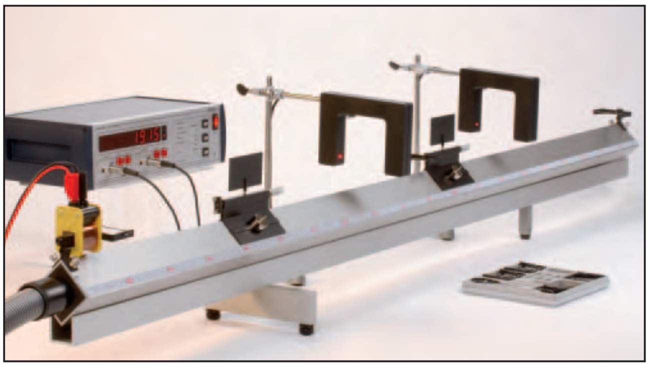
$$s = v_0 \cdot t + \tfrac{1}{2} \cdot a \cdot t^2$$

Required Equipment

1950.00	Air track, 2 m	1 pcs.
1970.60	Air blower 230 V	1 pcs.
1952.00	Electric launcher	1 pcs.
1975.50	Photocell unit	2 pcs.
1985.00	Switch box	1 pcs.
2002.50	Electronic timer	1 pcs.
3620.50	Power supply, 24 V AC/DC	1 pcs.
1965.00	Pulley with plug	1 pcs.

Cables

Elastic and inelastic collisions



Purpose

The goal of this experiment is to study collisions on an air track in order to confirm the conservation of momentum.

Theory:

In every physical process the momentum is conserved. For two masses in linear motion we have

$$m_1 \cdot u_1 + m_2 \cdot u_2 = m_1 \cdot v_1 + m_2 \cdot v_2$$

The glider masses are m_1 and m_2. The velocities of the two air track gliders before the collision are u_1 and u_2 and after the collision v_1 and v_2. The velocities are treated as *signed* quantities. This equation is valid for both elastic and inelastic collisions.
For *elastic* collisions the mechanical energy is conserved as well

$$\tfrac{1}{2} \cdot m_1 \cdot u_1^2 + \tfrac{1}{2} \cdot m_2 \cdot u_2^2 = \tfrac{1}{2} \cdot m_1 \cdot v_1^2 + \tfrac{1}{2} \cdot m_2 \cdot v_2^2$$

The velocities are computed based on

$$v = \frac{L}{t}$$

L is here the length of the air track glider flag and t is the passage time measured by the timer.

Procedure

Prepare the setup as shown in figure 1.
Measure the length of the air track glider flags, L
When determining the masses m_1 and m_2, the gliders must be weighed after mounting the accessories (springs, extra masses etc.). Make sure that you add the same mass to both ends of a glider – if you don't do that, the glider will "surf" with the heaviest end first.

Work through the following combinations – make a dry run each time to determine how to start the gliders in order to place the collision point appropriately relative to the photocell units

Collision / Masses	$m_2 = m_2$	$m_2 < m_2$	$m_2 > m_2$
Elastic	*	*	*
Inelastic	*	*	*

Don't let the gliders move too fast. If one of the gliders makes contact with the air track, the measurement is spoiled and must be repeated.

Fill out a table like the one below. A spreadsheet like Excel is very convenient for this work.

It is imperative to indicate whether each of the gliders moves towards the right (positive velocity) or towards the left (negative velocity). Already when filling out the table with experimental results. Don't forget to mark the times that correspond to negative velocities with minus signs.
If one of the gliders is at rest (zero velocity) the corresponding passage time should be marked "∞". If you use a spreadsheet, enter a very large number for infinity (e.g. 10^{23} – written 1E23).

Expressions for calculating momentum and kinetic energy:

$$p_{\text{Before}} = m_1 \cdot u_1 + m_2 \cdot u_2$$

$$p_{\text{After}} = m_1 \cdot v_1 + m_2 \cdot v_2$$

$$E_{\text{kin, Before}} = \tfrac{1}{2} \cdot m_1 \cdot u_1^2 + \tfrac{1}{2} \cdot m_2 \cdot u_2^2$$

$$E_{\text{kin, After}} = \tfrac{1}{2} \cdot m_1 \cdot v_1^2 + \tfrac{1}{2} \cdot m_2 \cdot v_2^2$$

Comment on your results – is momentum conserved? – When is kinetic energy conserved?
(Minor deviations from the expected figures are acceptable.)

Required Equipment

1950.00	Air track, 2 m	1,00 Pcs
1970.60	Air Blower 230V	1,00 Pcs
1975.50	Photocell unit	2,00 Pcs
2002.50	Electronic Scaler - Timer	1,00 Pcs

m_1	m_2	Before				After				p_{before}	p_{after}	$E_{kin, before}$	$E_{kin, after}$
		t_1	t_2	u_1	u_2	τ_1	τ_2	v_1	v_2				

Conservation of momentum in 2D-collisions

Purpose

In this experiment we want to verify the conservation of momentum in two dimensions.

Theory

Unlike for instance energy, velocity, $\boldsymbol{v}$, has not only a magnitude but also a direction – it is a vector. Defining the momentum $\boldsymbol{p}$ of a particle of mass m as $\boldsymbol{p} = m \cdot \boldsymbol{v}$ implies that the same is true for momentum. The total momentum of an isolated physical system is therefore independently conserved along any of the three axes x, y and z.

The system we are studying in this experiment is not isolated; the two balls are subjected to gravity. The total momentum of the balls is therefore not conserved along the z-axis but only along the x- and y-axes.

In this experiment, the balls fall freely after the collision – with no initial vertical velocity. The time it takes to fall a distance h is therefore given by

$$t = \sqrt{\frac{2 \cdot h}{g}}$$

where g is the acceleration of gravity.
When a ball moves the horizontal distance x along the x-axis in the time t, the x component of the velocity is simply given by

$$v_x = \frac{x}{t}$$

A similar expression can be used for the y component.

Procedure

Place a large piece of paper where the balls will hit the floor. To determine the precise spots where the balls hit, sheets of carbon paper are placed there. Write numbers immediately next to the dots and keep a log of the whole exercise.

Mark the position O directly under the collision spot using the string and bob. Measure the vertical distance h from the floor to the bottom of the balls when they are on the small horizontal (lower) part of the track. Use h to calculate the fall time t of the balls.

Let one steel ball roll down the track from the start position – it should fall freely to the floor without hitting the holder for the other ball. Use the spot where the ball hits the floor together with the point O to define the direction of the x-axis and to determine the initial, vertical velocity v_{x0} of the rolling ball. Calculate the initial x-momentum, p_{x0}, as well.

Draw a y-axis perpendicular to the x-axis. The initial velocity along this axis, v_{y0}, is clearly zero.
Now place the holder with the second steel ball in a position such that the two balls collide and fall freely to each side of the x-axis. From the dots on the paper you can calculate the momentum of each ball along the x- and y-axes – independently and respecting the sign of the y-position. (The y components of the momentum of the two balls will always have different signs.)
Adding the x components of the two balls' momentum should give the initial x-momentum, p_{x0}.

Adding the y components of the two balls' momentum should give a result close to zero.

Required Equipment

1992.20 Curved ball track	1,00 Pcs
1992.10 Easily smudged carbon paper	1,00 Pcs

Conservation of mechanical energy during a free fall

Purpose

In this exercise the conservation of mechanical energy during a free fall is studied.

Theory

The total mechanical energy of an object is determined by the sum of its potential energy and its kinetic energy

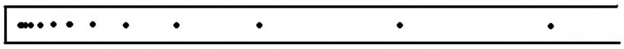
$$E_{mek} = E_{kin} + E_{pot}$$

In this experiment we will consider the kinetic energy to be equal to zero when the accelerated mass is at rest (v = 0). The zero point of the potential energy will be the position of the accelerated mass just before it is released. As the potential energy decreases (becomes negative) during the fall of the mass, the kinetic energy will increase (becomes positive) by – ideally – the same amount, so that the total mechanical energy should equal zero. In practice some energy losses due to friction, air resistance, etc. will be observed.

By letting a weight pull a timer tape through a timer, the timer can place a mark on the tape every 1/100 of a second[1] and by selecting a number of marks (e.g. 20) on the timer tape, one can find for each mark both how far the weight has fallen from the initial position as well as the speed of the weight at the moment in question.

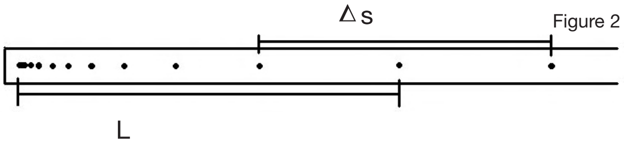
The first portion of the timer tape could look as follows after a typical experiment.

Figure 1



It is apparent that the distance between the marks increases as the speed of the falling weight increases. For each of the selected points on the tape two distances L and Δs should be measured as illustrated in figure 2

Figure 2



In order to determine the speed of the weight at a particular point one can use the fundamental definition of speed: $v = \Delta s/\Delta t$, where Δs is the distance through which the weight has traveled in the time interval Δt.

For a given mark on the tape using the distance from the previous mark to the following mark corresponds to a time interval of 0.02 seconds[2]. The speed is thus given by $v = \Delta s/0.02$ s.

For each of the selected marks on the timer tape the potential energy E_{pot} and the kinetic energy E_{kin} can be determined.

$$E_{kin} = \tfrac{1}{2}\cdot m\cdot v^2 \qquad E_{pot} = -m\cdot g\cdot L$$

the mechanical energy can be written as

$$E_{mek} = \tfrac{1}{2}\cdot m\cdot v^2 - m\cdot g\cdot L$$

The potential energy can be set equal to zero at the initial position of the weight. Thus the potential energy will be negative during the fall, while the kinetic energy will increase due to the increase in speed. The sum of the potential and the kinetic energy should thus remain close to zero.

[1] This is only true for an AC (mains) frequency of 50 Hz. If the frequency is 60 Hz the correct number is 1/120.

[2] For 60 Hz mains frequency the time interval is 0.01667 seconds.·

Procedure:

Mount the timer securely at a height L of about 2 meters over the floor. See illustration.

Place the timer tape in the timer being careful to allow the tape to pass on the correct side of the carbon paper. Attach the weight with the mass m to the timer tape. The timer tape should be about 10 cm shorter than the fall height.

Conduct the experiment. Start the timer, then immediately release the weight, so the tape is pulled through the timer. Retrieve the timer tape and analyze the results as described above

In a “perfect” experiment the total mechanical energy should be equal to zero during the fall of the weight, because the loss in potential energy is converted to a gain in kinetic energy. In practice of course this will not be fulfilled due to the friction of the tape moving through the holder and through the air, the mass of the tape and other factors.

Required Equipment

2005.00	Ticker tape timer	1,00 Pcs
2005.20	Tape	1,00 Pcs
2005.30	Carbon, 50 pcs.	1,00 Pack
2005.40	Drop weight, 1 kg	1,00 Pcs
2005.50	Drop weight, 1/2 kg	1,00 Pcs
2005.60	Drop weight, 1/4 kg	1,00 Pcs
3610.50	Power Supply 1-12 V AC/DC	1,00 Pcs

Rods, clamps, cables.

L	Δs	$v = \frac{\Delta s}{\Delta t}$	$E_{kin} = \frac{1}{2} \cdot m \cdot v^2$	$E_{pot} = -m \cdot g \cdot L$	$E_{mek} = E_{kin} + E_{pot}$

Wave interference

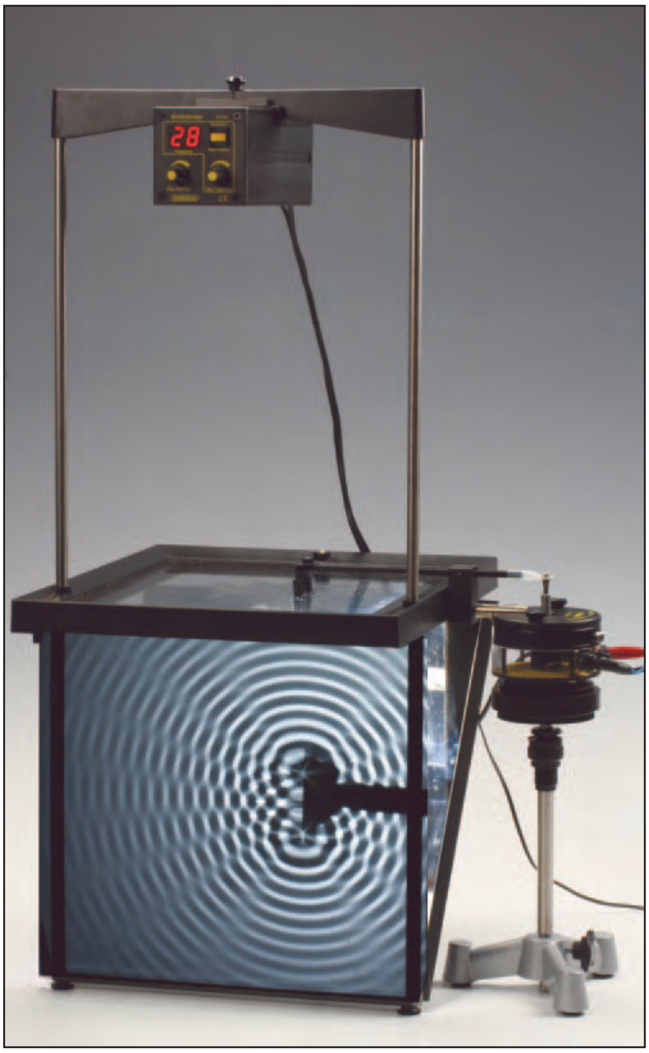


Fig. 1

Purpose

The goal of this experiment is to study the interference phenomenon that occurs when the waves originate from two point sources moving in phase. The same pattern develops when a plane wave encounters a barrier with two holes (or two slits). The classical double slit experiment in optics is an example of the latter.

Theory

When two waves meet they interfere constructively or destructively as overlapping wave amplitudes are added together to form an interference pattern. When the waves reinforce one another it is called constructive interference, and when the waves cancel one another out it is called destructive interference.

Figure 2 shows the interference pattern from two point sources. In figure 3 the directions where waves interfere constructively are shown in green while the red lines mark areas with destructive interference.

In case of the twin point sources, the directions where waves interfere constructively can be found by the following expression

$$\sin(\theta_m) = \frac{m \cdot \lambda}{d}$$

where θ_m is the angle between the direction in question and a line perpendicular to a line through the point sources, λ is the wave length, d is the distance between the sources, and m is an integer called the *order*. The different variables are illustrated on figure 3.

(This expression is a very good approximation as long as you don't look at the pattern in the immediate vicinity of the point sources.)

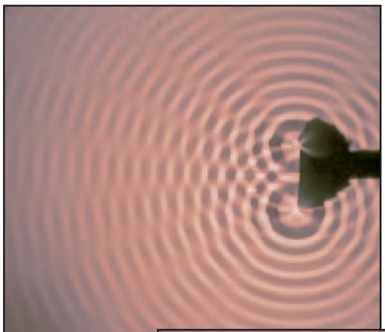


Fig. 2

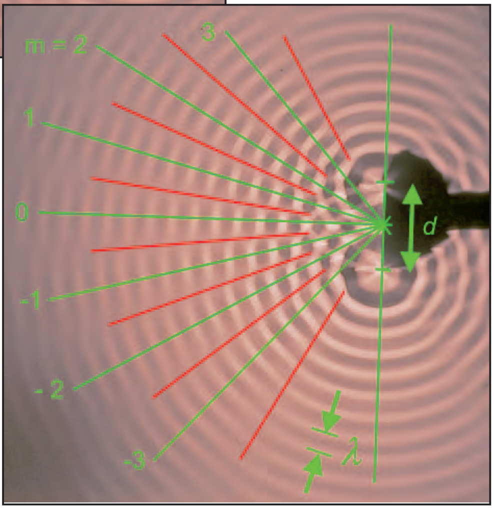


Fig. 3

Procedure

The mirror and screen are not used. Watch the wave pattern projected directly on the table top. Place a large sheet of paper to be able to mark important features of the patterns with a pencil.

The projected image is scaled by a **constant** factor compared to the physical waves on the water surface. This does not interfere with the validity of any of the formulae above, as long as we perform **all** measurements the same place. You will only work with the projected image in this experiment.

Mount the wave generator with two dippers. Mark the position of their shadows on the paper.

Measure the distance d between them (remember: on the projected image).

Adjust frequency and amplitude until you see a clear interference pattern like that in figure 2.

Mark the mid-point between the two dippers "X" and mark the directions where you observe constructive as well as destructive interference (use for different colors).

The direction perpendicular to the line through the dippers should follow the points with constructive interference in 0th order ($m = 0$).

Repeat this with different frequencies. Use a fresh sheet of paper for every experiment to avoid confusion.

Fill out a table as the one below for each frequency. The angle θ_m from the 0th order line to the mth order is measured on the paper by extending the lines all the way to the "X".
Compare the two bottom lines in the tables.

Required Equipment

2210.60	Ripple Tank	1,00 Pcs

	Experiment 1				
λ					
m	1	-1	2	-2	. . .
θ_m					
$m \cdot \lambda / d$					
sin (θ_m)					

	Experiment 2				
λ					
m	1	-1	2	-2	. . .
θ_m					
$m \cdot \lambda / d$					
sin (θ_m)					

Beat notes with two tuning forks

Purpose

To examine the relationship between the frequencies of two sound sources and the frequency of the beat notes Beat notes occur when two tones with frequencies close together interfere with one another. Beat notes sound like a slow variation in the intensity of the sound.

Theory

Consider two harmonic waves with the same amplitude A but different frequencies f_1 and f_2. When they interfere, the result may be expressed simply as the sum of the two components. By applying a well known trigonometric formula, this sum can be rewritten as follows

$$A\cdot\sin(2\pi\cdot f_1\cdot t)+A\cdot\sin(2\pi\cdot f_2\cdot t)=$$
$$2A\cdot\cos\left(2\pi\cdot\frac{f_1-f_2}{2}\cdot t\right)\cdot\sin\left(2\pi\cdot\frac{f_1+f_2}{2}\cdot t\right)$$

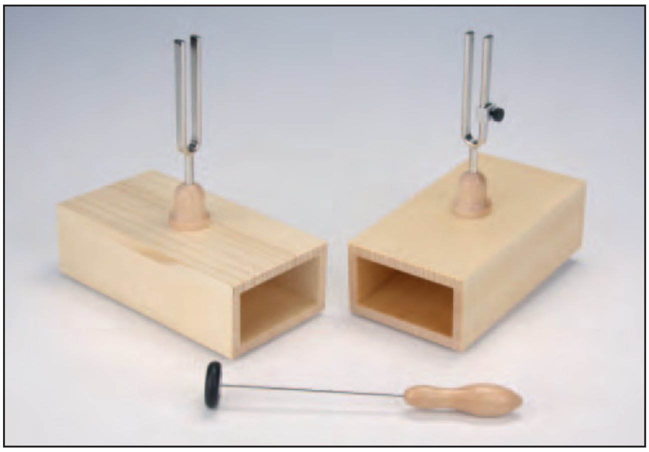
When the two frequencies f_1 and f_2 are close to each other, the right hand side of the expression can be viewed as a harmonic wave – the sine factor – with a frequency that is the mean value of f_1 and f_2. This wave has a slowly varying amplitude – the cosine factor – which varies with a frequency that is half the difference between f_1 and f_2.

As the ear has no way of distinguishing between the positive and negative signs of the cosine factor, the sound will appear to have **two** "beats" (i.e. maxima) per period of the cosine.

The beat frequency is therefore simply the difference between f_1 and f_2:

$$f_{\text{Beat}}=f_1-f_2$$

Procedure



1) Place the two resonance boxes with the two tuning forks close to one another with the openings facing towards each other.
   Beat notes can now be demonstrated by placing the runner on one of the tuning forks. Strike both of the tuning forks with approximately the same force. The beat note will be heard as a pulsing variation in the sound intensity. Adjust the runner until the frequency of the beats is about one pr. second.
2) Connect the microphone to the electronic timer and set it up as a frequency counter. Strike one of the tuning forks at a time, muting the other with your fingers. Note the frequency of each tuning fork.
3) Let the two tuning forks sound together again as above. Use the stop watch to measure how long it takes for a number of beats to happen. Ten is a convenient number.
   Be careful to count "zero, one, two, three…" – not just "one, two three…" – and start the stop watch exactly on "zero"

Calculate first the duration of one of the beats and next the beat frequency.

Compare the measured beat frequency with the one you get from the expression in the theory paragraph.

Required Equipment

2245.20	Tuning fork on resonance box (Set of two)	1.00 Pcs
2485.10	Microphone	1.00 Pcs
2002.50	Digital Scaler – Timer	1.00 Pcs
1485.40	Stop watch	1.00 Pcs

When sound waves are reflected at the ends of a tube, *resonances* occur at certain frequencies, giving rise to standing waves. This happens if the sound wave after two reflections is in phase with the original wave, resulting in an increased sound level at this particular frequency.
Surprising as it seems, sound is reflected not only at a closed end but also at an open one.

As the air cannot move into or out of a solid, pressure variations build up at a closed end. On the other hand, the air molecules are free to vibrate at the open end of a tube, resulting in minimal pressure variations.
The microphone used in these experiments measures the sound as variations in the air *pressure,* not the *velocity.* We will therefore concentrate on pressure variations in this treatment.

To the right some examples of resonances are drawn schematically.
Places with a **minimum** variation in sound pressure (e.g. at the open ends in the third drawing) are called **nodes,** marked N.
Places with a **maximum** variation in sound pressure (e.g. at the closed ends in the first drawing) are called **anti-nodes,** marked A.
Notice, that the distance between to neighboring nodes (or two anti-nodes) is one half of the wavelength λ.

As can be observed from these drawings, the length of the tube L and the wavelength λ cannot be chosen arbitrarily. They have to fulfill the *resonance condition.*

For a tube that is open or closed at *both* ends the resonance condition takes the form

$$L = n \cdot \frac{\lambda}{2}$$

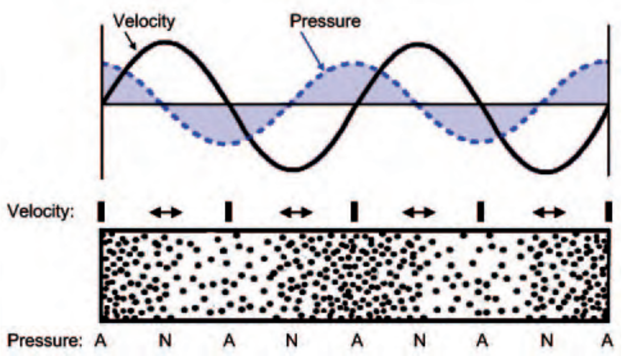
– where n is an integer and L is the effective length of the tube.
For a tube with one open and one closed end we have instead

$$L = n \cdot \frac{\lambda}{2} + \frac{\lambda}{4}$$

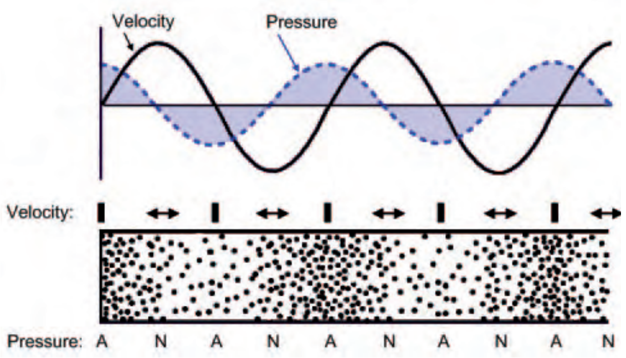
When open ends are involved, L is a little longer than the mechanical length. A node at an open end is positioned a little bit outside of the opening.
In any case the distance between two adjacent nodes (*or* anti-nodes) is

$$\Delta L = \frac{\lambda}{2}$$

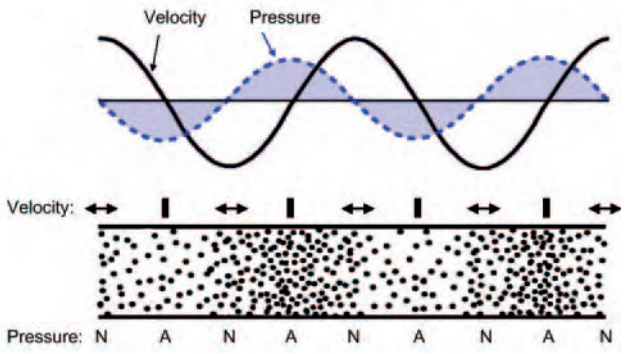
Closed ends



One end open, one closed



Open ends



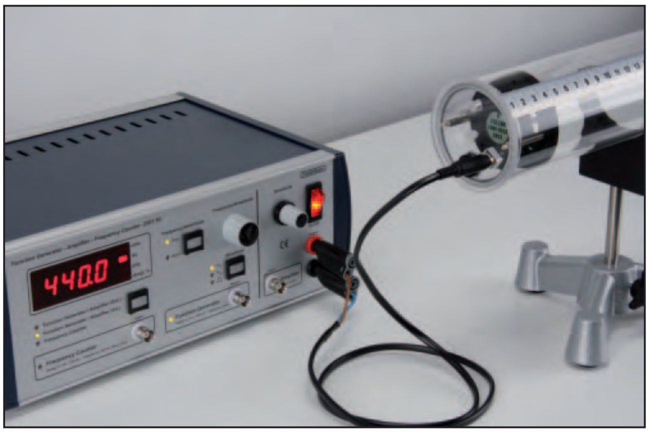
Standing waves in an air column

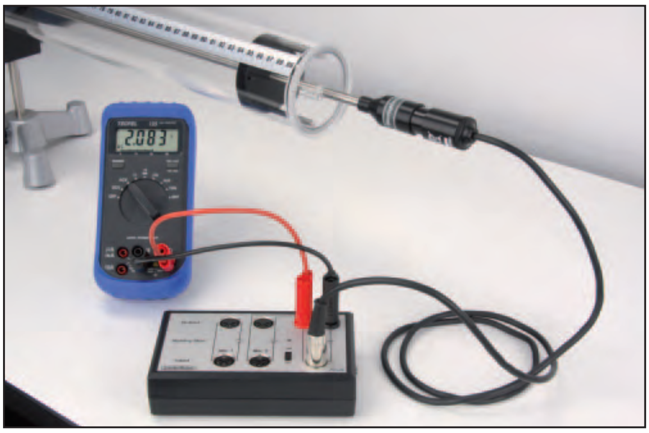
Purpose

This experiment investigates the positions of nodes and anti-nodes in a standing wave.

Theory

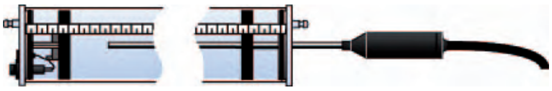
Please refer to the preceding page.





Procedure

A – Closed pipe



If the piston is in position in the tube, remove it. Put on both of the end caps. Connect the microphone and the loudspeaker as shown.
Insert the microphone probe with only the tip through the end opposite the loudspeaker.
Adjust the frequency f to approximately 1000 Hz and check that the meter is giving a reading. Next the frequency should be adjusted to a resonance (a maximum reading). This happens for instance at around 953 Hz if the temperature is 20 °C. Keep the frequency fixed.

Now insert the microphone probe slowly into the resonance pipe and observe the waning and waxing of the amplitude of the sound.
Determine the position of a number of nodes (or anti-nodes) this way. Use the results to calculate the wavelength λ.

Is there a node or an anti-node at the end of the tube? Was this as you expected?

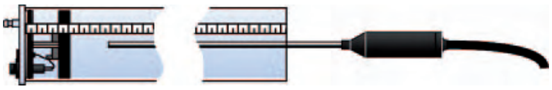
The velocity of sound can be found when wavelength and frequency are known:

$$v = f \cdot \lambda$$

Compare this to the table value for dry air at temperature T_C (centigrade):

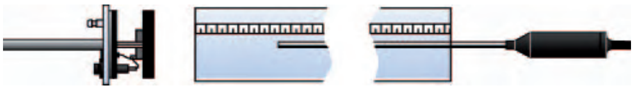
$$v_{\text{dry-air}} = 331.3\,\tfrac{\text{m}}{\text{s}} + 0.606\,\tfrac{\text{m}}{\text{s}\,°\text{C}} \cdot T_C$$

B – Half-open pipe



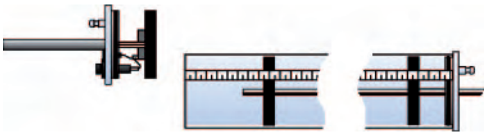
Remove the microphone probe from the end cap and remove the cap completely. Place the tip of the microphone into the tube about 8 cm from the end.
Start again at about 1000 Hz and search for a resonance. You may hit one near 993 Hz – depending on the temperature.
Repeat the examination of nodes and anti-nodes as in part A. Compare with theory.
Can you determine the exact position of the node at the end of the tube?

C – Open pipe



Remove the end plug with the loudspeaker and place it 2 to 3 centimeters from the end of the tube (use a retort stand and a bosshead).
Continue with the same procedure as in part B.
A suitable resonance should exist near 943 Hz.

D – Half-open pipe with variable length



Keep the loudspeaker in the position used in part C. Insert the piston through the hole in the end cap and insert the end cap in the other end. Pull the piston as far out as you can, making the resonance tube as long as possible.
Now chose some fixed frequency e.g. 1000 Hz. You may position the tip of the microphone probe a few centimeters into the open end of the tube – or you may simply rely on your ears in the following.

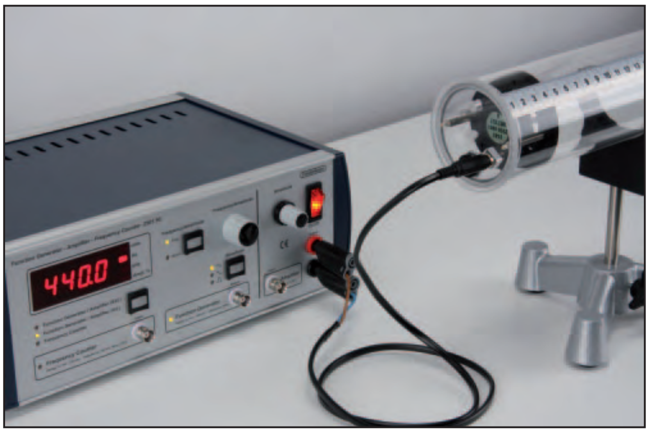
Instead of adjusting the frequency, you should now slowly press the piston into the tube, reducing its length. First time the length fulfills the resonance condition the sound level increases.

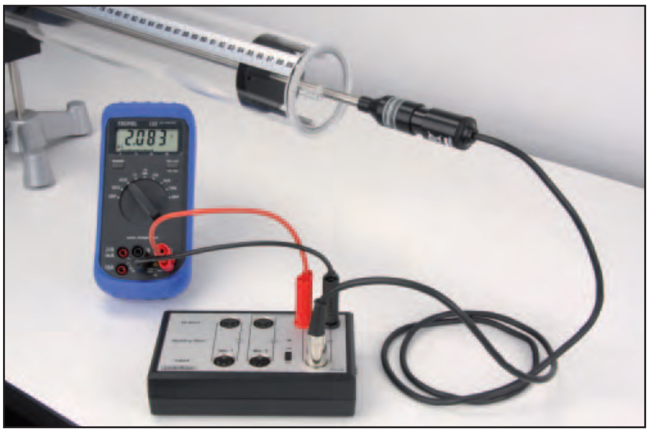
Try to predict the rest of the resonance positions of the piston using your previous results – then check if your predictions were right.

Required Equipment

2480.10	Resonance pipe	1.00 Pcs
2515.50	Microphone probe	1.00 Pcs
2501.50 (or 2500.50)	Function generator	1.00 Pcs
(2002.50 Digital Scaler - Timer; frequency measurement if 2500.50 is used)		
2515.60	Power supply	1.00 Pcs
3862.15	Digital voltmeter (an oscilloscope may also be used)	1.00 Pcs
(3862.15 Multimeter)		

The speed of sound in CO_2





Purpose

In this experiment we measure the speed of sound in a gas.
CO_2 is suggested – ordinary air works just as well.

Theory

Please refer to separate page.

Procedure

If the piston is in position in the tube, remove it. Put on both of the end caps. Connect the microphone and the loudspeaker as shown.
Insert the microphone probe with only the tip through the end opposite the loudspeaker.
Adjust the frequency f to approximately 100 Hz and check, that the meter is giving a reading.

Now the resonance pipe must be filled with CO_2. Let the gas flow rather slowly to avoid cooling the apparatus too much. Wait a few minutes after filling the pipe to allow it to go back to room temperature.

Adjust the frequency to a resonance (a maximum reading) and write it down. The lowest possible resonance frequency should occur at around 150 Hz in CO_2 (190 Hz in air). This is known as the fundamental or first harmonic frequency. At this frequency, the length of the tube is $\lambda/2$.

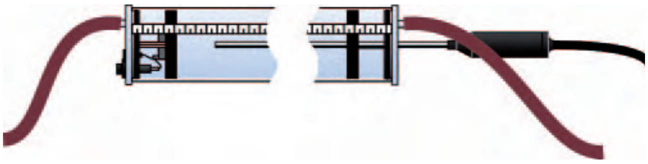
Now double the frequency and search for the resonance of the second harmonic frequency (length of tube equals λ). Go on with third, fourth … n'th harmonic. Write down the exact frequency for each resonance. For every harmonic, the wavelength can be found from the resonance condition.
The velocity of sound can be found when wavelength and frequency are known:

$$v = f \cdot \lambda$$

Compare your results with the theoretical expression for an ideal gas:

$$v = \sqrt{\frac{c_p \cdot R \cdot T}{c_v \cdot M}}$$

– where R is the gas constant, T is the absolute temperature, c_p and c_v are the specific heat at constant pressure resp. constant volume, M is the molar mass.
(In case of a mixture of gasses – e.g. air – use the weighed averages for c_p, c_v and M.)



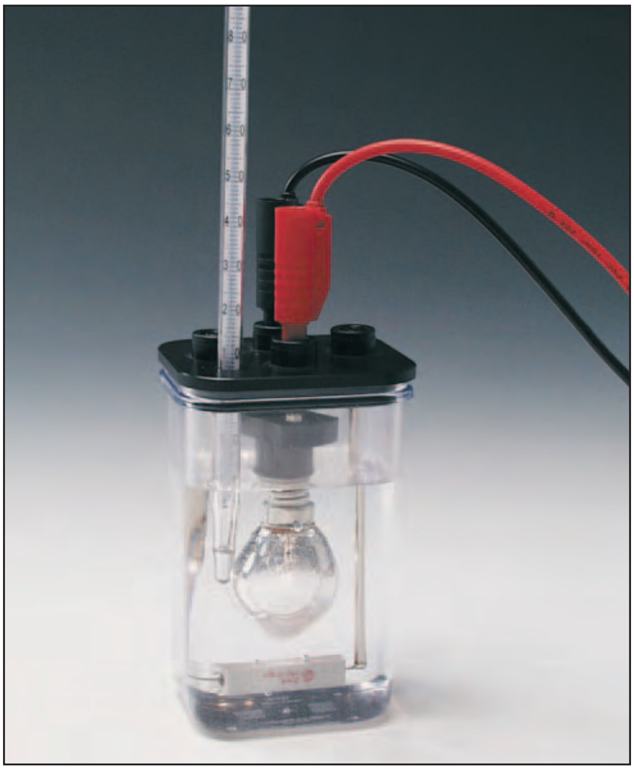
Required Equipment

2480.10 Resonance pipe	1.00 Pcs
2515.50 Microphone probe	1.00 Pcs
2501.50 (or 2500.50) Function generator	1.00 Pcs
(2002.50 Digital Scaler - Timer; needed if 2500.50 is used)	1.00 Pcs
2515.60 Power supply	1.00 Pcs
3862.15 Digital voltmeter (an oscilloscope may also be used)	1.00 Pcs
Carbon dioxide	

Efficiency of an incandescent lamp

Purpose

In this experiment you will determine the amount of energy that is radiated away from the filament of an incandescent lamp. This energy is partly visible and partly infrared light.



Theory

For a resistor, almost all the electric energy applied is turned into thermal energy. This is noticed as a rise in temperature.

$$E_{el,resistor} = E_{th,resistor}$$

When lighting an incandescent lamp, the electric energy applied to the bulb is converted to radiation as well as to thermal energy.

$$E_{el,bulb} = E_{rad,bulb} + E_{th,bulb}$$

In these measurements we will keep current, voltage and time constant, which means that the amount of supplied electric energy will be the same for each measurement.

$$E_{el} = I \cdot U \cdot \Delta t = constant$$

The thermal energy transferred to the system is proportional to the rise in temperature.

$$E_{th} = C \cdot \Delta T$$

Procedure

You will perform an initial adjustment followed by three measurements.
Every time, fill the apparatus with **the same** amount of cold water; enough to cover the light bulb.

Start with the voltage a little below 6 V. Switch the cable between lamp and resistor and adjust the voltage so that the currents are the same. Leave the voltage setting on the power supply in this position. Just turn the power off.

1st measurement: Fill the apparatus with cold water. Determine the temperature of the water. Hook up the cables to make the current go through the resistor. Switch on for 120 seconds. Switch off. Shake the apparatus gently to let it reach thermal equilibrium, and measure the temperature again. Calculate the rise in temperature ΔT_1

2nd measurement: Refill the apparatus with cold water and find the start temperature. This time the current should go through the bulb. Leave the current on for 120 seconds, switch off, shake gently, and measure the temperature. This time we call the rise in temperature ΔT_2

3rd measurement: Cover the bulb with a small piece of aluminum foil. A thin rubber band may be used around the neck of the bulb. Repeat the procedure again – call the rise in temperature ΔT_3

Calculations

1 – In the second measurement, some of the energy leaves the system as radiation, and the temperature does not rise as far as in the first. From the equations above you can calculate the percentage of the energy that is converted into radiation. The result is (remember to do the calculations yourself!):

$$\eta = \frac{\Delta T_1 - \Delta T_2}{\Delta T_1} \cdot 100\%$$

Try to find a figure of the efficiency of an incandescent light bulb on the Internet and compare that to the value that you obtained. Explain any observed difference.

2 – Comparing situation 1 and 3, you will notice that although the physical devices are different, the energy flows are the same. (The light does not leave the system and is ultimately converted into thermal energy.) One should expect the two rises in temperature to be equal. Is this what you observed?

Required Equipment

3207.00	Apparatus for the study of light energy	1.00 Pcs

Power Supply
Thermometer, Cables

Purpose

The goal of this experiment is to help visualize the physics of the optical grating. This is accomplished by assembling and testing a large scale version of a grating.

Theory

It can be difficult to visualize the physics of an optical grating, so textbook explanations are most often based on drawings. This grating model is an optical grating with a very large groove spacing - large enough for the “lines” to be easily seen with the naked eye.

Here students can directly observe the structure of the grating and see the result of sending monochromatic light through it. Note by the way that the very first optical gratings were produced in 1820 by Joseph von Fraunhofer (1787-1826), an optical worker in Munich. He stretched fine wires between two parallel threaded rods, and he was able to resolve the sodium D-lines (a pair of spectra lines close together around 589 nanometers).

The grating equation is as follows:

$$\sin(\theta) = \frac{n \cdot \lambda}{d}$$

where d is the grating spacing, θ is the deviation angle, n is the order of the diffraction maximum with respect to the center of the pattern, and λ is the wavelength of the light from the laser. To determine the position of the 0’th order maximum, make a mark on the screen where the laser beam strikes without a grating in the beam.

The deviation angle can also be calculated through geometry, allowing us to test the grating equation. The angle θ can be found from the equation $\tan(\theta)=a/L$, where the distances *a* and *L* can be seen in the figure 1. (For small angles $\tan(\theta) \approx a/L$, so the grating equation can be rewritten in simpler form for younger pupils:

$$\frac{a}{L} = \frac{n \cdot \lambda}{d}$$

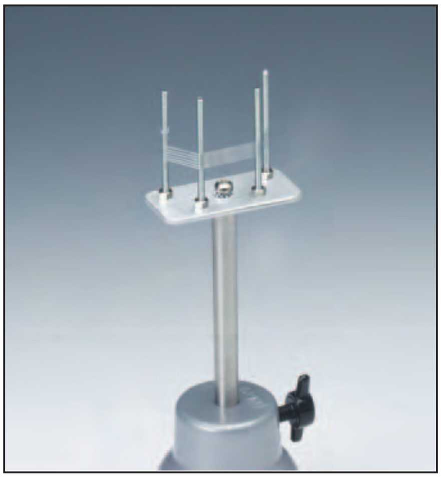
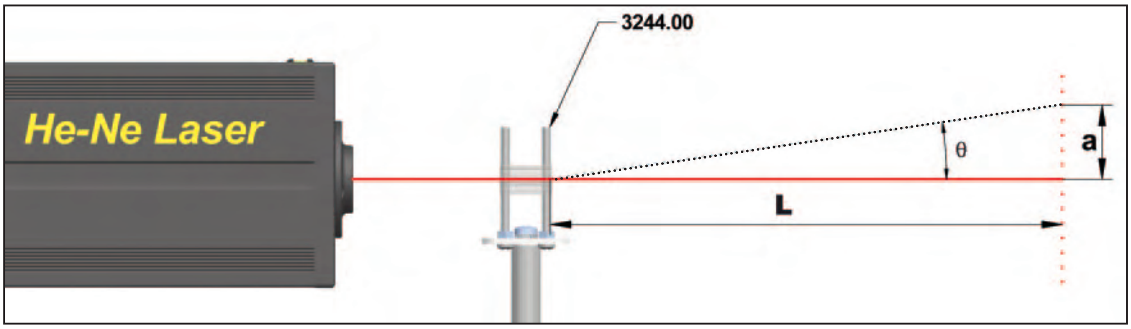


Fig. 2

Procedure:

1. The optical grating model is assembled as indicated in the user’s manual.
2. Wind the nylon thread around the posts to form the grating. It is important that the nylon string be stretched tightly as it is wound.
3. Send laser light e.g. from a diodelaser or a helium-neon laser perpendicular to the plane of the grating.
4. The diffraction pattern can be observed on a screen or wall some 5 or 6 meters away. The greater the distance between the grating and the viewing surface, the larger and more visible the diffraction pattern becomes.
5. Measure the distance L from the grating to the screen, and the distance *a* between the 0’th order and the selected order, n.
6. Read off or find the wavelength λ of the laser, and use a caliper to determine the grating spacing d, for example by measuring the distance between 10 threads and dividing by 10
7. Calculate θ according to the grating equation, $\sin(\theta)=n \cdot \lambda / d$
8. Calculate θ according to geometri $\tan(\theta)=a/L$
9. Compare the values of θ

Fig. 1



Distance L	Distance a	Order n	Wavelength λ	Groove Spacing, d	$\theta = \sin^{-1}\left(\frac{n \cdot \lambda}{d}\right)$	$\theta = \tan^{-1}\left(\frac{a}{L}\right)$

Notes:

This experiment can be extended by using finer optical gratings such as:

3250.20 Optical grating, 300 lines/mm
3250.30 Optical grating, 600 lines/mm

Required Equipment

3244.00 Grating Model	1.00 Pcs
Laser (1420.70 2885.85 2885.10 2885.20)	1.00 Pcs
1440.20 Caliper gauge, SS	1.00 Pcs
0004.00 Retort stand base	1.00 Pcs

Induction of electric current

Purpose

To demonstrate the induction of electrical current from a coil due to a changing magnetic field

Theory

When the magnetic field around a coil changes, an electrical potential is induced in the coil. The induced voltage can cause a current to flow if the coil is connected to a circuit. The direction of the current flow will induce a field around the coil which opposes the change in the original magnetic field.

By conducting this experiment it can be shown that the rate at which the change in the magnetic field occurs influences the strength of the induced electric current. Furthermore it can be shown that the number of windings in the coil influences the strength of the induced current.

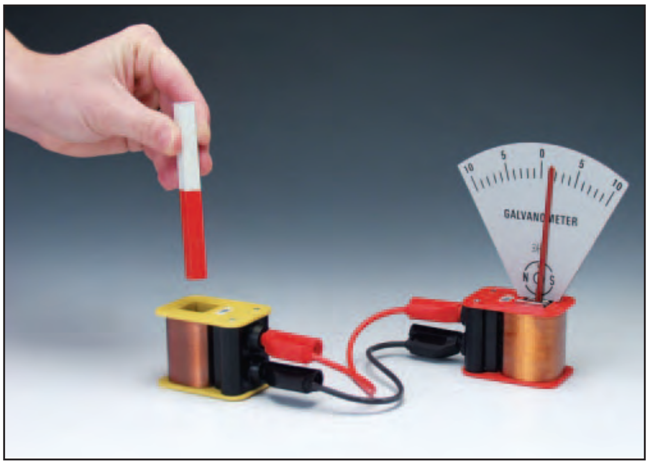


Fig 1

Procedure

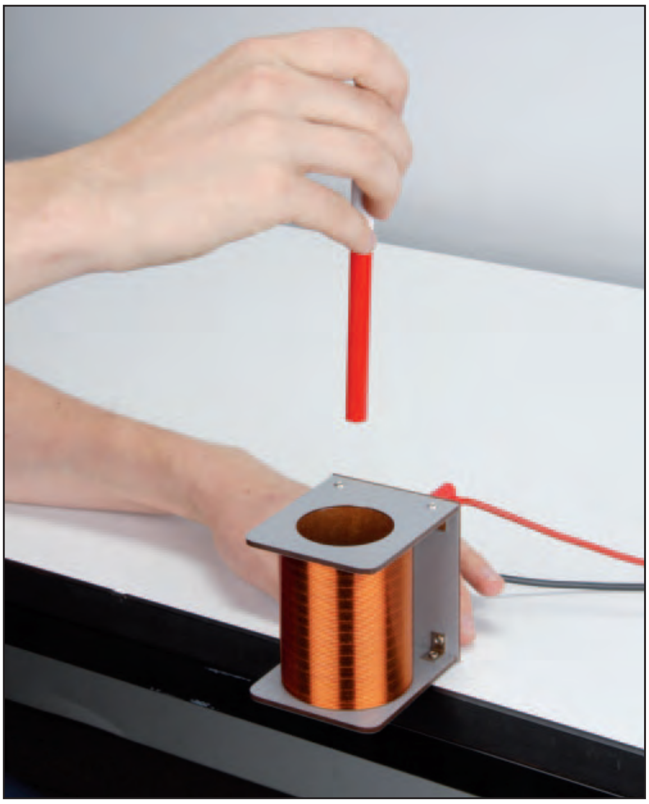
1. Connect a coil with 400 windings to a coil with 1600 windings, as shown in figure 1.
2. Insert the galvanometer accessory into the coil with 1600 windings.
3. Now move the bar magnet down into the coil with 400 windings and observe the deflection on the galvanometer. Note that the current changes direction when the magnet is drawn upwards out of the coil. Reverse the direction of the bar magnet so that the opposite pole points downward, and repeat the experiment. What do you observe?
4. By moving the magnet quickly or slowly in and out of the coil one can observe the connection between the rate of change of the magnetic field and the induced current.
5. In order to investigate the effect of the number of windings on the magnitude of the induced current, place an additional coil (with 800 windings) in series with the two other coils (so that the total resistance in the circuit remains the same during the experiment). Now try using uniform motions of the bar magnet to study the effect the different number of windings has on the magnitude of the induced electrical current.

Required Equipment

4625.20	Coil, yellow, 400 wdg.	1.00 Pcs
4625.25	Coil, grey, 800 wdg.	1.00 Pcs
4625.30	Coil, red, 1600 wdg.	1.00 Pcs
4640.00	Galvanometer insert	1.00 Pcs
3305.10	Bar magnets, Al-Ni-Co	1.00 Pcs

Cables

Induction - using a data logger



Purpose

To demonstrate Faraday's law of induction.

Theory

According to Faraday's law of induction, the induced electromotive force $\mathcal{E}$ (or voltage) in a coil with N windings is given by the expression

$$\mathcal{E} = -N \cdot \frac{d\Phi_B}{dt}$$

where Φ_B is the magnetic flux through the coil. Integrating this expression yields

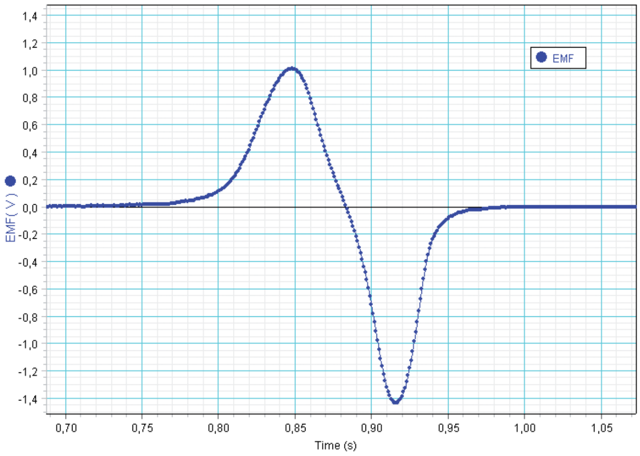
$$\int_{t_1}^{t_2} \mathcal{E} \cdot dt = -N \cdot \left(\Phi_B(t_2) - \Phi_B(t_1)\right)$$

If we consider the special situation where the flux is the same (e.g. zero) at times t_1 and t_2, the right-hand side of the equation is zero. If a graph of $\mathcal{E}$ vs. time is drawn, the area between the graph and the time axis will consist of equally large areas above and below the axis.

Procedure

Connect the coil to a voltage sensor input on your data logger. Adjust the sampling rate to for instance 1000 Hz. Place the coil over the edge of a table – keep it in place by your hand or something not made of metal. Have a piece of soft material (a piece of foam – or a foot) to drop the magnet onto. Hold the magnet some 10 to 15 cm above the coil to approximate the zero-flux situation mentioned in the previous paragraph.

Start the data logging and let go of the magnet; it should fall freely through the coil. Stop the data logger.
A sample graph is shown below. The magnet falls with a constant acceleration, therefore the area above the time axis is broader than – but not as high as – the one below the axis.



(In the example shown the areas differ by 0.16 % – showing excellent agreement with theory.)

Required Equipment

3305.00	Bar magnets, Al-Ni-Co	1.00 Pcs
4590.40	Coil, 600 windings	1.00 Pcs

Data logger with voltage sensor

Cables

Laplace's law 1

Purpose

The goal of this experiment is to measure the force on a conductor placed in a magnetic field, when a current flows in the conductor. The force depends on the current flowing in the conductor, the length of the conductor, the magnetic field strength and the angle between the direction of current flow and the magnetic field.
In this experiment the angle will be fixed at 90°.

Theory

According to Laplace's Law the force due to a magnetic field on a conductor is proportional to the length of the conductor, the magnitude of the current through the conductor, the magnetic field strength and the sine of the angle between the direction of current flow and the magnetic field. In this experiment the angle is 90° and Laplace's law takes the following form

$$F = I \cdot L \cdot B$$

Where F is the force on the wire due to the magnetic field, B is the magnetic field strength, I is the current, L is the length of the wire.

By changing the parameters one at a time, Laplace's Law can be verified

Procedure

Place the magnet assembly on a sensitive scale. Put the conductor in position at the end of the arm of the current balance (start with for instance L = 4.0 cm). Position the arm so that the conductor is completely within the region of uniform magnetic field.
Readings in grams may be converted to a force in newtons: $F = m \cdot g$. For example, a value of "5 grams" corresponds to a force of

$$0.005\,\mathrm{kg} \cdot 9.82\,\frac{\mathrm{m}}{\mathrm{s}^2} = 0.0491\,\mathrm{N}$$

a) Force vs. length of conductor

According to Laplace's law, the force is proportional to the length of the conductor. Keeping I and B constant, this can be expressed as $F = const. \cdot L$

1. Set the current to zero (e.g. by breaking the circuit), and zero the scale if possible (press the tare button).
2. Set the current to a constant value, e.g. 4,5 A, and take a reading from the balance. Note that the values observed may be negative depending upon the orientation of the B-field. If the scale has problems with "negative weight" you can change the direction of current.
3. Repeat this process for various conductor lengths. Use the same current as before.
4. Present your results in a table like the one below, and draw a graph of force vs. length.

Looking at the calculated values in the last column – what would you expect and what do you in fact observe? Same question for the graph!

Length L (cm)	"Weight" m (g)	Force F (N)	$k_1 = \frac{F}{L}$

b) Force vs. current

According to Laplace's law, the force is proportional to the current in the conductor. Keeping L and B constant, this can be expressed as $F = const. \cdot I$

1. Use the longest conductor length e.g. L = 8 cm. Use this conductor for the rest of the experiments.
2. Set the current to zero by breaking the circuit, and zero the scale as before.
3. Change the current through the circuit. The current must **not** exceed 5A. Read off the corresponding value from the scale, and note the values in a table like the one below.
4. Fill out the table and draw a graph of force versus current.

Again: what would you expect – and what do you in fact observe when you look at the values of k_2?
Same question for the graph!

Current I (A)	"Weight" m (g)	Force F (N)	$k_2 = \frac{F}{I}$

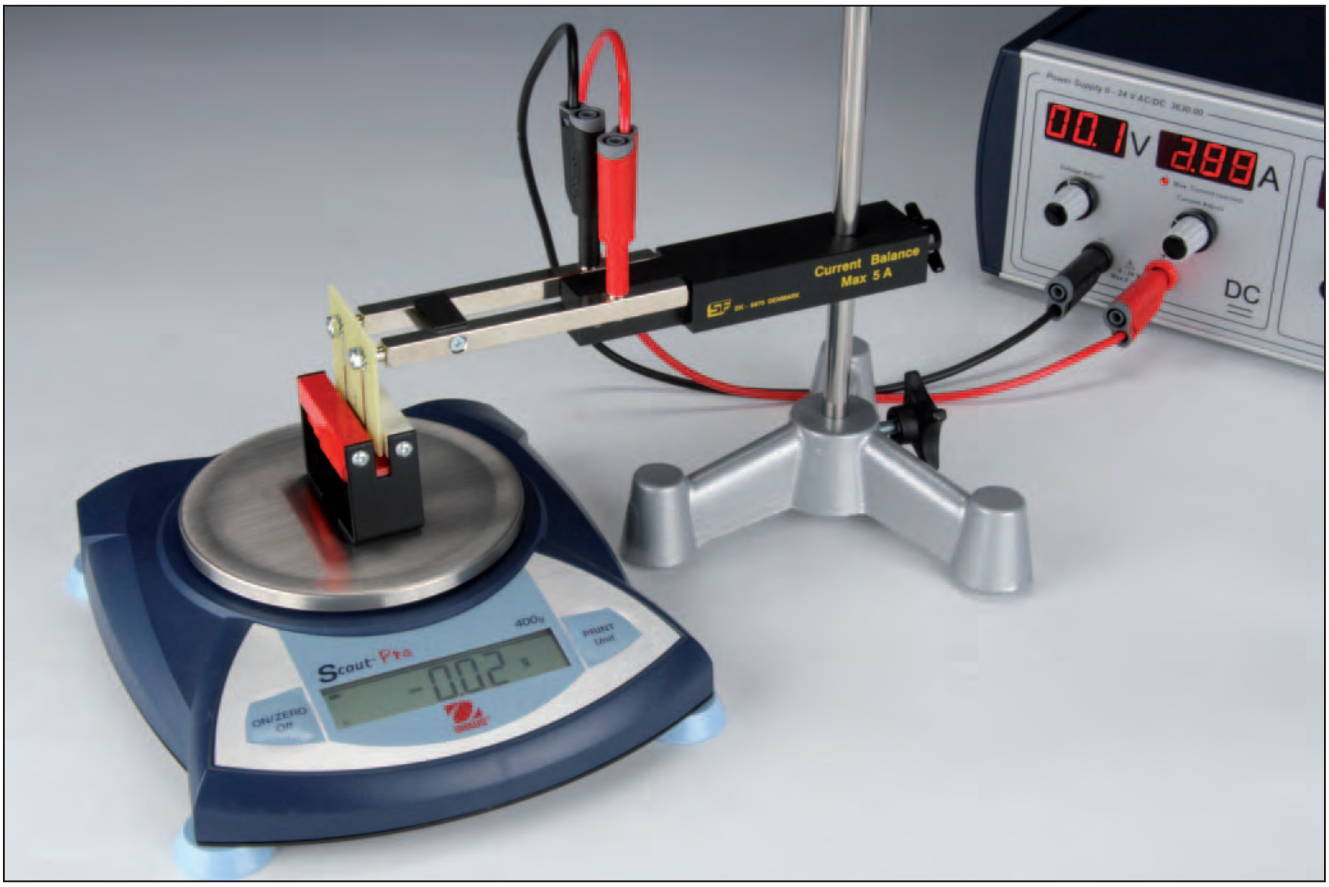
c) Force vs. magnetic field

(This is a slightly advanced extension of the experiment. We will only sketch this part.)
The final parameter in the Lorentz force law is the strength B of the magnetic field which can be changed by removing some of the magnets from the assembly. It can not be assumed that the field strength is directly proportional to the number of magnets. However the field can be measured using a teslameter. Note that this experiment requires that the setup be carefully adjusted and zeroed again after each measurement with different numbers of magnets.

Required Equipment

4565.00	Current Balance	1.00 Pcs
3630.00	(or equiv.) Power Supply	1.00 Pcs
1029.70	Digital Scale	1.00 Pcs
4060.50	Teslameter)	1.00 Pcs

Retort stand, cables, ammeter (3862.15)
– if not built-into the power supply.



Laplaces's law 2 (angle dependency)

Purpose

In this experiment we study the force on a conductor placed in a magnetic field, when a current flows in the conductor. The force depends on the current flowing in the conductor, the length of the conductor, the magnetic field strength and the angle between the direction of current flow and the magnetic field.
Here we will investigate the dependency on the angle.

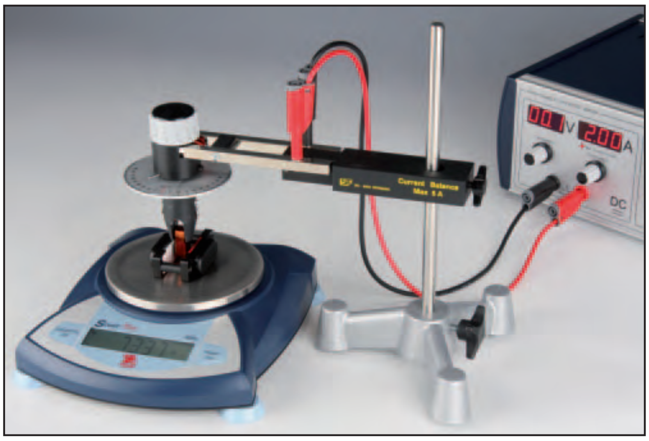
Theory

According to Laplace's law the force due to a magnetic field on a conductor is proportional to the length of the conductor, the magnitude of the current through the conductor, the magnetic field strength and the sine of the angle between the direction of current flow and the magnetic field

$$F = B \cdot I \cdot L \cdot \sin(\theta)$$

Where F is the force on the wire due to the magnetic field, B is the magnetic field strength, I is the current, L is the length of the wire and θ is the angle between current flow and magnetic field.
For now we want to keep B, I and L at constant values, only varying θ. Laplace's law can then be written

$$F = const. \cdot \sin(\theta)$$



Procedure

Place the magnet assembly from Current Balance II (4565.10) on a sensitive scale. Place the Current Balance II at the end of the arm of the Current Balance (4565.00). Position the arm so that the lowest part of the coil is completely within the region of uniform magnetic field. Turn the knob all the way from end to end to check that the coil moves freely without touching the magnet.
Readings in grams may be converted to a force in newtons: $F = m \cdot g$. For example, a value of "5 grams" corresponds to a force of

$$0.005\,\mathrm{kg} \cdot 9.82\,\frac{\mathrm{m}}{\mathrm{s}^2} = 0.0491\,\mathrm{N}$$

.

1. Zero the sensitive scale while no current is flowing.
2. Turn on the current. Keep it at a constant value – e.g. 4.5 A (max. 5.0 A).
3. Turn the knob on Current Balance II to a position where the scale reads zero grams. Adjust the moveable angle indicator on the goniometer so that it reads zero degrees too. In this position the magnetic field is parallel to the current flow.
4. Adjust the angle between the conductor and the magnetic field in 10 degree increments. Read off corresponding "weight" values from the scale. If the scale allows readings below zero, go through both negative and positive angles. Note the signs carefully.
5. Fill out a table like the one below and draw a graph of force versus sin(θ).

Looking at the calculated values in the last column – what would you expect and what do you in fact observe? Same question for the graph!

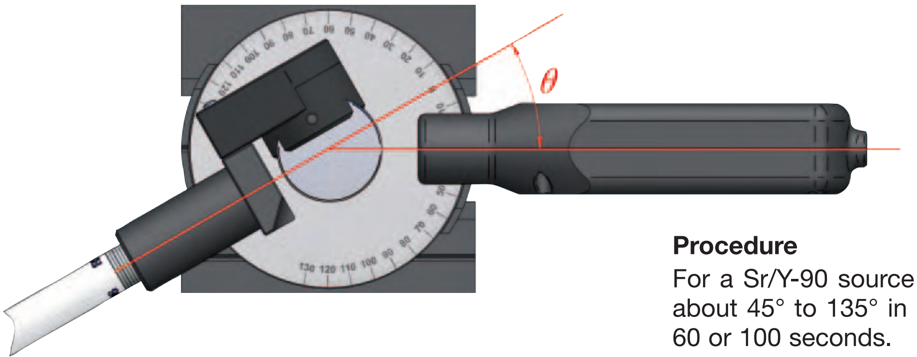
Angle θ (°)	»Weight« m (g)	Force F (N)	sin(θ)	$k = \frac{F}{\sin(\theta)}$

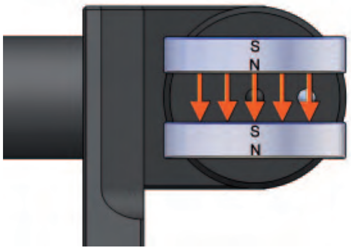
In this apparatus the conductor takes the form of a rectangular coil. The forces on the two vertical parts of the coil cancel each other. (Exercise: Explain why!) The magnet is designed so that the field weakens fast outside the homogeneous region between the pole shoes. Therefore the upper vertical part of the coil "feels" a magnetic field much smaller than the lower part does. This simply causes the proportionality constant in (2) to diminish a few percents. (Exercise: Why is it diminished and not increased?)

Required Equipment

4565.00	Current Balance	1.00 Pcs
4565.10	Current Balance II	1.00 Pcs
3630.00	(or equiv.) Power Supply	1.00 Pcs
1029.70	Digital Scale	1.00 Pcs

Retort stand, cables, ammeter (3862.15)
– if not built-into the power supply.





Purpose

In this experiment you will plot the continuous energy spectrum of the β-decay of Sr/Y-90.

Theory

The beta particles are deflected in a permanent magnetic field B. Calling the deflection angle θ, the energy E of the β-particle is given by the equation in the diagram below, where e and m_0 is the charge and rest mass of the electron, c is the speed of light and R is the radius of the magnets. In this relationship we ignore the (somewhat large) uncertainty of θ, and we assume the magnetic field to be homogeneous in the gap between the magnets and to drop abruptly to zero outside.

For a typical magnetic field strength for this apparatus (310 mT) the relationship is plotted below.

Procedure

For a Sr/Y-90 source you should vary the angle θ from about 45° to 135° in 5° steps. For each angle, count in 60 or 100 seconds.

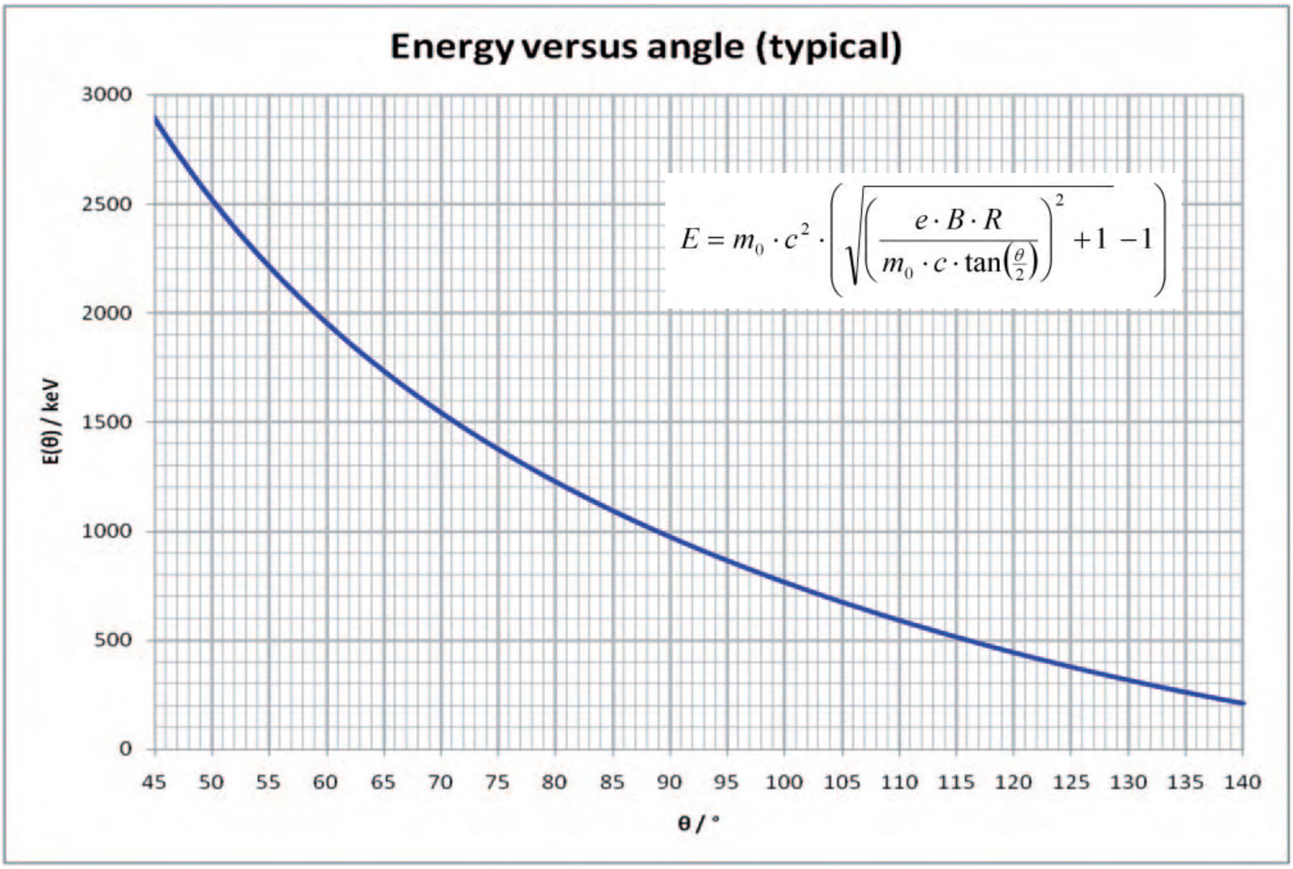
Remember to do a background count with the beta source removed. Plot the corrected counts versus angle.

(If you want to compare the result with textbook graphs, you must scale the individual counts appropriately to correct for the fact that this measurement is per angle interval while the graph should actually be drawn per energy interval. More info can be found in the manual for the apparatus.)

Required Equipment

5141.05	Deflection of beta particles	1.00 Pcs
5125.15	GM detector	1.00 Pcs
5135.3x	GM counter	1.00 Pcs
(– or	5135.70 GM detector and 2002.50 counter)	
5100.02	Beta source	1.00 Pcs

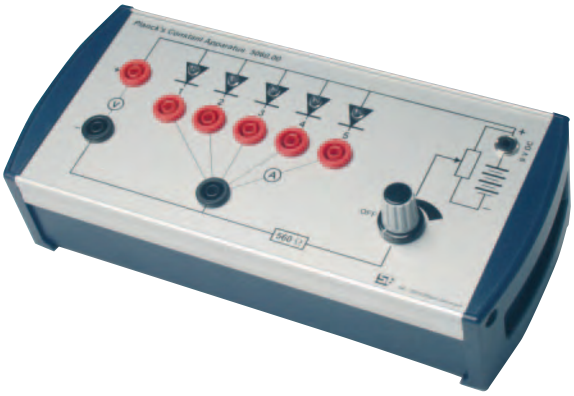
Please see page 149 for source/equipment options.



$$E = m_0 \cdot c^2 \cdot \left(\sqrt{\left(\frac{e \cdot B \cdot R}{m_0 \cdot c \cdot \tan\left(\frac{\theta}{2}\right)} \right)^2 + 1} - 1 \right)$$

Purpose

This experiment permits a simple determination of Planck's constant using the "turn on" voltage of light emitting diodes (LEDs).



Theory

Various types of semiconductors have different band gap energies E_G. As electrons pass the pn-junction, some will recombine with holes and emit a photon of energy $h \cdot f = E_G$ where f is the frequency of the light and h is Planck's constant. Expressed in terms of wavelength λ:

$$E_G = \frac{h \cdot c}{\lambda}$$

The band gap energy corresponds to a potential U_0 given by $e \cdot U_0 = E_G$ where e is the elementary charge.
The current flow in a forward biased pn-junction increases exponentially as the applied voltage approaches U_0. Determining U_0 precisely requires a closer investigation of the temperature dependency of the diode current – which is beyond the scope of this experiment. Instead we will use the "turn on" voltage for the LED as an approximation to U_0.
When the "turn on" voltage U for a LED is known, the corresponding electron energy can be found using $E = e \cdot U$. Thus the equation:

$$e \cdot U = h \cdot f$$

Procedure

The unit can operate using its internal battery supply or using a net adapter with an output voltage of 9 volts DC. The net adapter is connected to the jack at the upper right hand side of the instrument. If battery power is used, be sure that the battery is installed and fresh.

Hook up the meters: The current is measured by connecting the ammeter between a LED cathode and the black safety jack terminal as shown on the faceplate. Connect a voltmeter to the voltmeter terminals on the left side of the apparatus.
(This setup is convenient although one introduces a small error by including the voltage drop of the ammeter. With a good digital ammeter like 3862.15 this can be ignored, but you may of course instead prefer to connect the negative terminal of the voltmeter to the same LED cathode as the ammeter.)

Now choose a small fixed current value to use in the experiment (5 mA is appropriate).

Turn the potentiometer clockwise to increase the voltage until the current through the LED reaches the chosen value. Make a note of this voltage. Turn the current down.
Repeat this procedure for the other LEDs.

Fill out a table like the one on the following page with your results.
Plot the electron energy E as a function of the frequency f for all five LEDs.
Draw the best straight line through the data points and find Planck's constant h as the slope of the line.
Compare your value with the table value $6.63 \cdot 10^{-34}$ Js.

It can be convenient to do the calculations and to draw the graph in a spreadsheet like Excel. The program can also draw a linear fit and find the slope of the line – you may want to include the origin (0 Hz, 0 J) in the fit.

LED:	UV	Blue	Yellow	Red	IR
Wavelength λ (nm)	405	466	595	640	940
Turn-on voltage U (V)					
Frequency f (Hz)					
Electron engergy E (J)					

Example: Compute the frequency of the light.
The red LED has a wavelength $\lambda = 640$ nm $= 6.40 \cdot 10^{-7}$ m

Using $f = \frac{c}{\lambda}$ we find $f = 4.684 \cdot 10^{14}$ Hz

Example: Compute the electron energy.
If a "turn on" voltage of 1.60 V is measured for the red LED, then the electron energy is
$E = e \cdot U = 1.602 \cdot 10^{19}$ C · 1.60 V $= 2.563 \cdot 10^{19}$ J

Required Equipment

5060.00	Planck's Constant	2 Pcs
3862.15	(or equiv.) Digital multimeter	2 Pcs

Cables

0001.00 . . . 4
0004.00 . . . 4
0004.10 . . . 4
0006.00 . . . 4
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0008.00 . . . 4
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